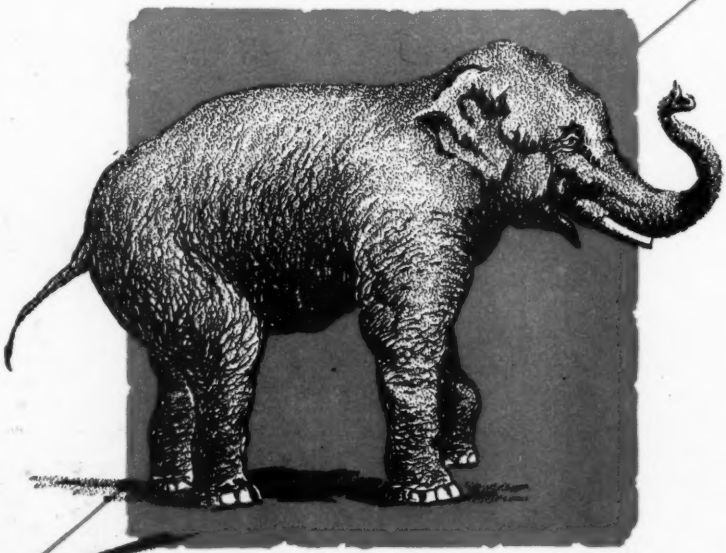
THE MONTHLY

Review

JULY • • • 1947

Do Your barrel deburred BRASS parts suffer from PACHIDERMITUS ?

A ROUGH SURFACE LIKE THE HIDE OF AN ELEPHANT



Then Investigate the CLEPO **SPEE-D-BURR** * Process for barrel deburring and burnishing. Removes tool marks and burrs, smooths surface irregularities and develops a high polish on Brass, without peened edges or orange-peel surface.

* PAT PENDING

FREDERICK **GUMM** *Chemical Company Inc.*

538 FOREST STREET, KEARNY, N. J.

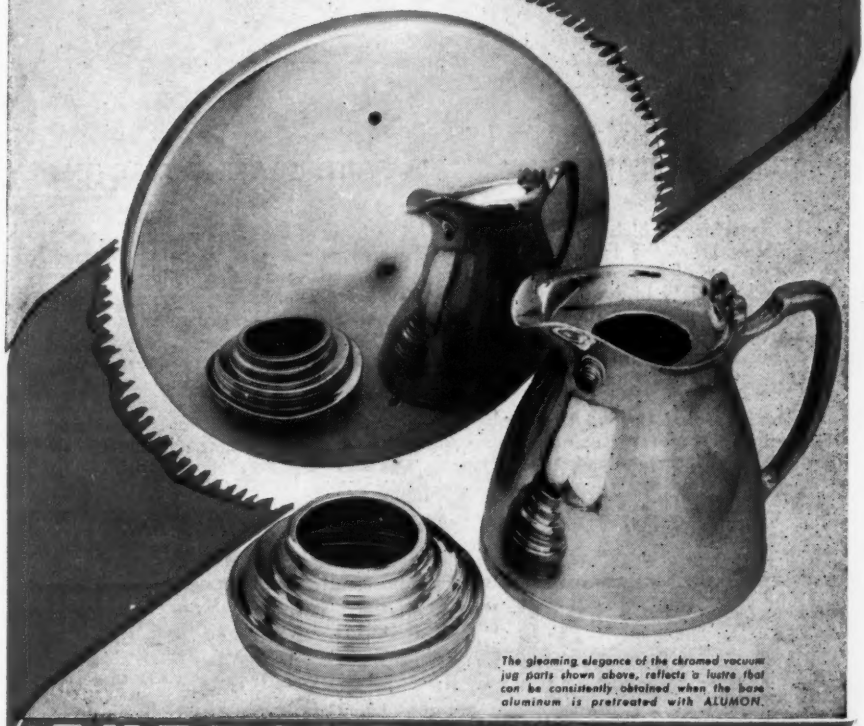
ALUMON

A PROCESS FOR ELECTROPLATING UPON ALUMINUM

"ALUMON" is a simple process for preparing aluminum for plating. Aluminum is cleaned, acid dipped and then immersed for about 1 minute in the "Alumon" solution at room temperature. A zinc alloy film is deposited that serves as a base for plating almost any metal including copper, nickel, silver, cadmium, zinc and tin.

"ALUMON" is a practical, production proven process in use in several hundred plants for plating jewelry, hardware, camera parts, chairs, automobile parts, engine cylinders, lamps, flashlights, buckles, buttons and plumbing goods. Barrel plating is possible for solid aluminum.

Samples of work plated and operating cycle determined free of charge.



The gleaming elegance of the chromed vacuum jug parts shown above, reflects a lustre that can be consistently obtained when the base aluminum is pretreated with ALUMON.

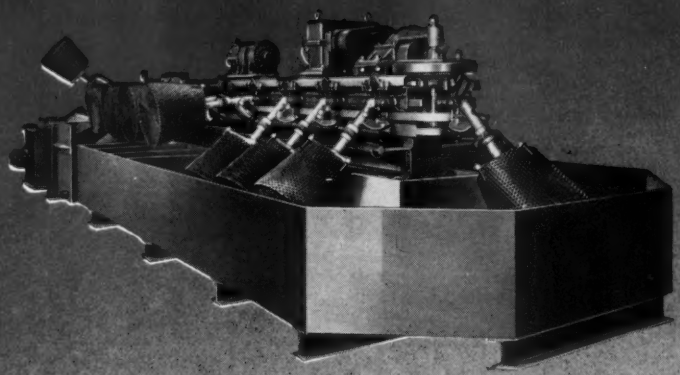
ENTHONE, INC.

442 Elm Street

New Haven 2, Conn.

METAL FINISHING CHEMICALS • ELECTROPLATING EQUIPMENT

Did You See It at the Detroit Exposition?



STEVENS "STANDARD" SMALL PARTS PLATING MACHINE

This machine, which was exhibited in our booths at the Industrial Finishing Exposition of the American Electroplaters' Society in June, is a standard, complete Full Automatic Small Parts or Barrel Plating Unit, built to meet the popular demand for a medium-sized automatic installation.

Cleaning, acid treatment, rinses, plating, drying and automatic unloading operations are all incorporated in this machine.

Can be used for cadmium, zinc, copper, nickel or tin plating of small parts. Wide variations in the plating cycle can be had instantly by means of fully developed method of control.

Requires the services of one operator only to load the machine.

No overhead construction. Overhead hoists and duck boards eliminated, low operating and maintenance cost.

Write for folder giving complete specifications

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THE MONTHLY

Review

VOLUME 34 JULY 1947 NUMBER 7

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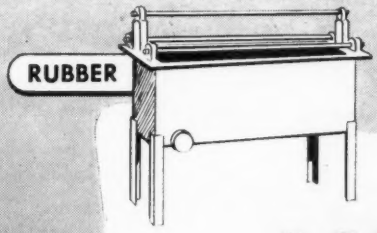
Wyandotte Porenac is of such versatility that it probably can be adapted to *your* specific problem, whether it be cleaning prior to porcelain enameling, barrel-plating, oxide finishing or other heavy-duty cleaning operations.

Your Wyandotte Representative will gladly tell you more about this and other Wyandotte Metal Cleaners. A call will bring him.

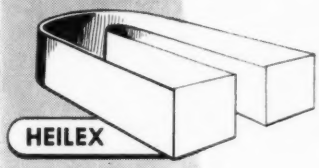
Wyandotte
REG. U. S. PAT. OFF.

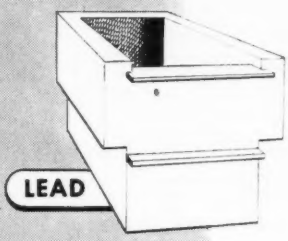
SERVICE REPRESENTATIVES IN 88 CITIES

WYANDOTTE CHEMICALS CORPORATION
Wyandotte, Michigan



LININGS
TO FIT THE JOB





Heil Process Specialists have no soft spot for any single lining or insulating material. They know that temperature, abrasion, absorption and contamination are factors that affect all choices. They recommend and supply the lining best suited to the needs of the process. The lining is installed separately or as part of the complete job.

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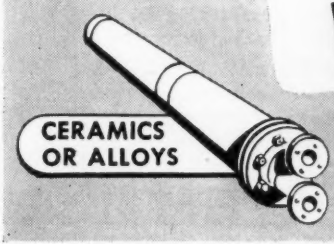

HEIL CHEMICAL PROOF EQUIPMENT
ANODES • TANKS • DUCTS • TANK FIXTURES
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fabricated to your specifications

Filter All Plating Solutions Faster, More Completely in

SPARKLER *Horizontal Plate* FILTERS

Because the filter cake is held horizontally, it is absolutely stable to the end of each filtering cycle. And cycles are longer because the cake retains its porosity longer. That is why the "horizontal principle," as embodied in Sparkler filters, gives you more efficient, low cost, operation. Sparkler filters are pressure-tight and leak-proof, designed for intermittent or continuous operation.

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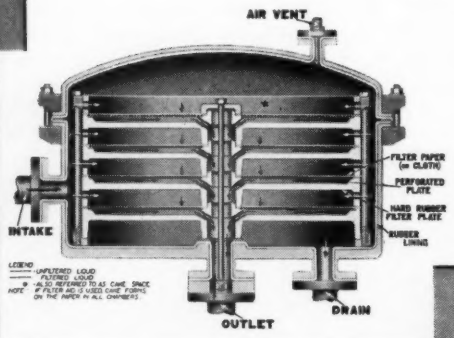
1. Rubber-lined for bright nickel
2. Stainless steel for acids
3. All Iron for alkaline solutions
4. All Steel (with Stainless Pump) for chromium

SPARKLER MANUFACTURING CO.
Mundelein, Illinois



Made in Capacities 60 to 10,000 G.P.H.

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Our Engineering Service is available for any specialized problems.

Automatic plating power units

Packaged for increased plating efficiency

• Here is the modern way to achieve continuous, uniform plating operations. General Electric "packaged" power units are flexible, and bring automatic control of tank voltage to the plating room.

Take a look at the features of a typical General Electric plating package:

1. A General Electric "2000" copper-oxide plating rectifier provides efficient, dependable power.

2. Automatic induction-type, motor-operated rectifier control provides smooth, steady voltage at the tank.

3. Operator's control box governs all operations, and can be located wherever it is most convenient for the user.

Wrap them all up, and you have a combination that *automatically* maintains constant tank voltage from "no load" to "full load" within ± 2 per cent of selected reading at all times.

In addition, use of the General Electric "2000" rectifier gives you complete flexibility to meet changing production needs. The General Electric "2000" is available in a number of different output ratings, for example: one model provides 3 to 6 volts, 2000 amperes, or 6 to 12 volts, 1000 amperes; another model is rated 4.5 to 9 volts, 1250 amperes, or 9 to 18 volts for 625 amperes.

We'd like to tell you more about the cost-saving features of packaged plating power. If you would like a copy of our comprehensive catalog, *General Electric Copper-oxide Rectifiers and Controls,* write to Section A65-758, Appliance and Merchandise Department, General Electric Company, Bridgeport 2, Connecticut.

GENERAL ELECTRIC

Extra Purchase Where It Counts Keeps Them Moving

LONG hauls of heavy loads were risky ventures until trucks and trailers were equipped with extra sets of wheels. Then road accidents decreased sharply and delays due to failures became much less frequent. Today no trucking company can afford to dispense with this additional support for fast moving loads.

Tanks for long runs of heavy production in plating service need the extra support that Stortswelded construction gives—efficient design, stout welding, linings of properly selected material and fittings correctly installed. Storts experience built into your tanks can help you to keep production moving.

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INCORPORATED
42 Stone Street Meriden, Conn.

Manufacturers of Welded Fabrications to Specification

An Egyptian Finish

BEAUTIFIES AND PROTECTS

Mix Crafter

An Attractive Specialty by Chrom-Craft Division of American Fixture & Manufacturing Co., St. Louis, Mo.

The attractive Mix Crafter is finished with Egyptian's High Bake NFR. Exceptionally fine two-tone color combinations are achieved by normal application of this specialized Egyptian finish.

The right finish is more than mere surface protection . . . so put your regular or special finish requirements up to Egyptian. Inquiries are invited.

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MEAKER

Full Automatic Plating Machines

STRAIGHT-A-WAY RETURN TYPE

1. Economy of Operation

. . . all heavy, tiresome, messy work is done by the machine.

2. Better Quality

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3. Maximum Output

. . . heavy duty and carefully engineered design insures uninterrupted production schedule.

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MEAKER PROCESS GALVANIZING LINES

For

Strip Steel **Round Wire**

★

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VARIABLE SPEED
LATHES

Reliance Variable Speed Lathes Cut Costs

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LONGER FINISH-LIFE

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GREATER EYE APPEAL

WITH

BLACK MAGIC

This is a sheet metal oil heater, manufactured in large quantities and finished with BLACK-MAGIC. BLACK-MAGIC was selected for the drum of this stove because its simplicity makes it possible for the manufacturer to secure an attractive finish and good corrosion and heat resistance at an economical cost. This is but one of thousands of uses for BLACK-MAGIC.

BLACK-MAGIC is an integral finish, not a coating; actual penetration is .0001". Very flexible. Products may be formed after processing—often an advantage. Also an excellent bond for paint and lacquer. Chemical reaction at 300° F. For iron and all steels except stainless. There are also BLACK-MAGIC baths for zinc, copper, brass and cadmium. Send for samples and the interesting "Black Book" of facts.

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FOR THE ELECTROPLATER

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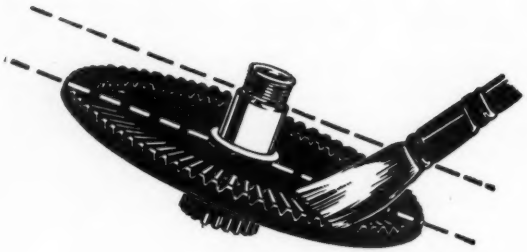
- BICHROMATE OF SODA
- CHROMIC ACID

MUTUAL CHEMICAL COMPANY OF AMERICA
270 MADISON AVENUE NEW YORK 16, N.Y.

UNICHROME stop-off lacquers



Help you do a better job . . . in less time!

EASILY APPLIED—by brushing, spraying or dipping—these tough synthetic lacquers assure clean-cut edges, withstand hot cleaners and acid dips, and will not contaminate plating baths.

FAST DRYING—in 5 to 10 minutes, at room temperature.

QUICKLY REMOVED—by peeling off or dissolving in remover solution, depending on type of stop-off used.

Stop-off 322 (Black) Extra adherence for severe cycles, including hot cyanides. Removed by dissolving in Remover 322-RA.

Stop-off 323 (Red) For Chromium and other moderate-temperature cycles. Readily peeled off at room temperature.

Stop-off 324 (White) For all high temperature solutions. Resists hot alkaline cleaners, vapor degreasers for limited time. Easily peeled off while warm.

UNICHROME

Trade Mark Reg. U. S. Pat. Off.

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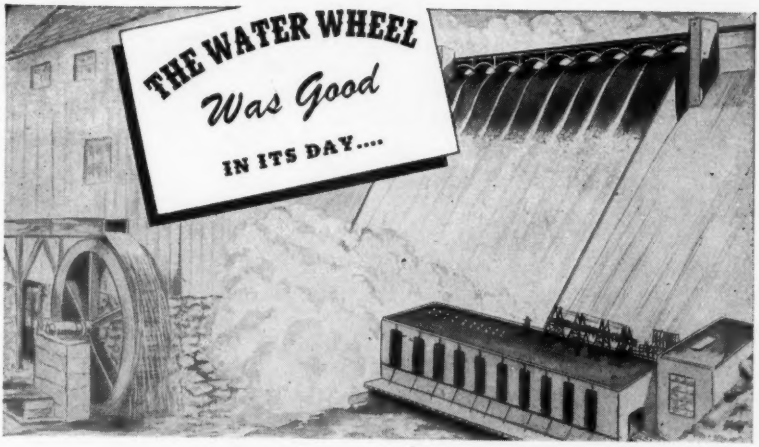

BUT...

Improvement in design has produced the super hydro-electric plants and other engineering marvels of the present. In the metal-working field

Alodizing with

Alodine*

provides protection for both painted and unpainted aluminum comparable to that of anodically formed coatings but at a fraction of the cost in time, materials, labor, and equipment.

Alodizing aluminum means simultaneously coating and sealing the metal in an easily prepared chemical bath. Time: 2 minutes maximum. No current. No high temperatures required.

Simple, economical and effective, Alodine gives aluminum the great corrosion resistance and tenacious paint adhesion formerly possible only with costly and time-consuming processes.

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Duridine *
Alodine *
Lithoform *
Thermoil-Granodine *

RUST REMOVING AND PREVENTING

Deoxidine *
Peroline *

PICKLING ACID INHIBITORS

Rodine *

AMERICAN CHEMICAL PAINT CO.
AMBLER ACP PENNA.

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EMULSION SOLVENT CLEANER

Because LIXOL works fast and is a dependable emulsion cleaner for still tank, presoak or washing machine equipment, it is preferred for many metal cleaning operations. It can be used straight or diluted with water or kerosene.

- LIXOL penetrates
- LIXOL cleans thoroughly
- LIXOL prevents rust

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THE COWLES DETERGENT CO.

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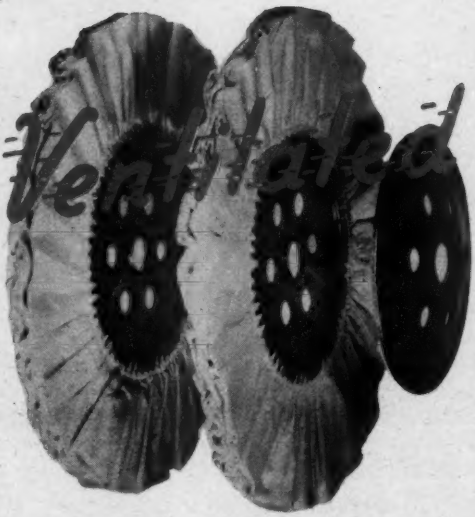
THEY ALWAYS
HAVE
and
ALWAYS WILL
SAVE
50%

THE NO-RAVEL BUFF
WEARS TWICE AS LONG
COSTS HALF AS MUCH

Our production capacity is being EXPANDED!

AIRWAY BUFFS



will CONTINUE to save you

50% ON COTTON BUFF WHEEL COSTS!

AIRWAY *Ventilated* BUFFS improved and perfected, do better work faster and wear twice as long.

AIRWAY *Ventilated* BUFFS are constructed in many different types for all purposes. A wheel for every requirement designed for low-cost production.

IN YOUR PLANS FOR THE FUTURE—bear in mind...

1 **AIRWAY *Ventilated* BUFFS** *will be available in greater quantities*

2 **AIRWAY *Ventilated* BUFFS** *cost half as much—wear twice as long*

Important Features of AIRWAY *Ventilated* BUFFS

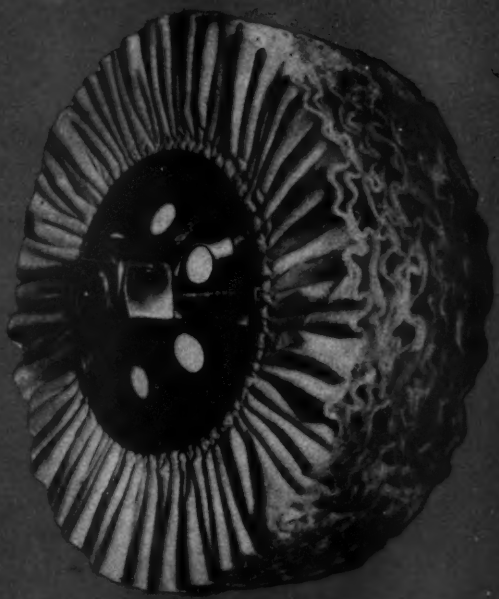
- Raveling eliminated, requires no raking
- Eliminates burning
- Saves compound
- Faster cutting and does not ridge work

WARNING NOTICE

Jackson Buff Corporation of Long Island City, New York, has rights to U. S. Patents Nos. Re 19,894 and 2,140,208 which have broad claims covering an air cooled buff having means for the admission of air through the sides of the buff. Owner intends to protect all rights and stop infringement.

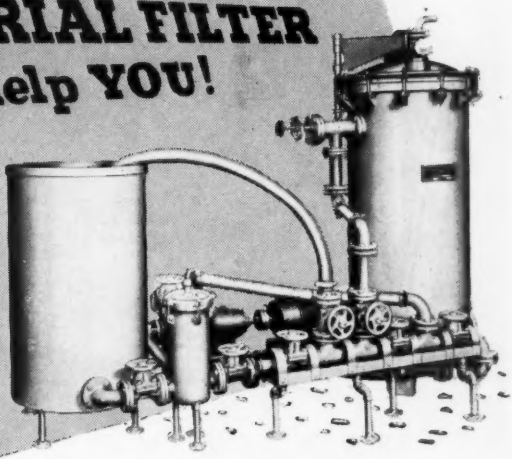
JACKSON BUFF Corporation

21-03 41st AVENUE • LONG ISLAND CITY 1, NEW YORK, N. Y.



A modern INDUSTRIAL FILTER will help YOU!

- Cut your plating costs
- Speed up production
- Produce quality plating
- Eliminate numerous plating troubles

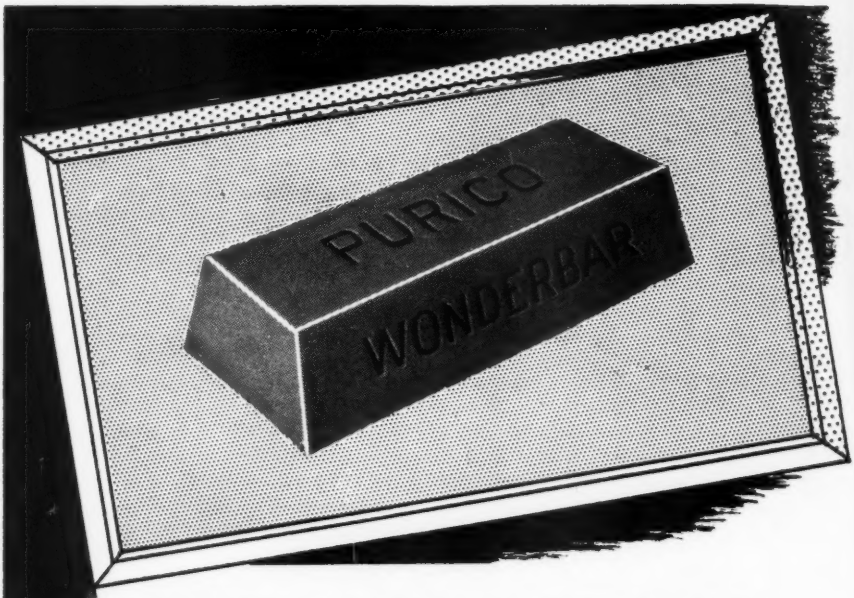


Only CLEAN plating solutions can produce clean, non-porous plated coatings. The low cost for clarifying plating solutions with INDUSTRIAL FILTERS is really a saving as rejects are reduced and quality is greatly improved. Continuous clarification (filtering) also creates a beneficial circulation.

Illustration of a typical large capacity complete stationary filter system designed to provide adequate filtration on large automatic plating machines. Arrangement consists of filter, pumping unit, primer-strainer unit, mixing tank, control valves, fittings and piping. These features facilitate the convenient use of filter aids and purifying agents, making it an ideal continuous filtration system, equally effective for intermittent filtering. Systems are provided for either acid or alkaline solutions.

FOR TWENTY YEARS "INDUSTRIAL" HAS BEEN BUILDING PLATING SOLUTION FILTERS THAT HAVE ENJOYED AN OUTSTANDING REPUTATION FOR: RUGGEDNESS, DEPENDABILITY, LOW UPKEEP COST, LONG LIFE AND BED ROCK OPERATING ECONOMY. THAT'S WHY SO MANY PLATERS SAY: I PREFER THE "INDUSTRIAL" WAY.

INDUSTRIAL
FILTER & PUMP MFG. CO.
1621-39 WEST CARROLL AVENUE • CHICAGO 12, ILLINOIS



HERE'S THE PICTURE

Today, the wheels of industry are geared to peace time production . . . competition is keener. Aware of this, the Metal Finishing Industry demands a buffing compound that assures not only the bright surface required for perfect plating but one that saves time . . . reduces labor costs . . . speeds up production.

Purico WONDERBAR satisfies these requirements! *It's a pre-saponified Tripoli bar composition for efficient and economical buffing of metal parts. It lasts longer on the wheel . . . does not tarnish work . . . speeds up production by eliminating extra manual scrubbing.* Soluble in mild alkali, WONDERBAR rinses quickly from intricate patterns and eliminates expensive degreasing machines.

Start with a Good Finish

★ ★ THE *Puritan* ★ ★

MANUFACTURING COMPANY
29 BENEDICT STREET
WATERBURY, CONNECTICUT

Does It for ZINC!

You can protect your zinc plated products and at the same time produce a brilliant finish easily and quickly. Promat Pro-Seal can be used following the famous high speed Promat No. 90-S zinc plating process or can be used to treat any pure zinc surface. Pro-Seal uses no current. Can be hot rinsed or oven dried. Simple to control and very economical.

Independent testing laboratory reports prove that the bright Pro-Seal finish will prevent formation of white corrosion particles in salt spray and humidity tests and meets the specifications of refrigerator shelf manufacturers. Pro-Seal simplifies the production of protected bright zinc plated products.

The value of durable brilliant zinc is obvious. Manufacturers of cabinet shelving, hardware automotive parts and hundreds of other products can use Pro-Seal on zinc to great advantage. Pro-Seal is an excellent alternate for unobtainable prewar finishes and also creates a new field for zinc plated products.

Pro-Seal consists of two simple dips. Concentrates of these baths are shipped in carboys and drums.

Distributors in principal cities—write to

PROMAT DIVISION—Poor & Company

851 SOUTH MARKET STREET WAUKEGAN, ILLINOIS

Engineering Electroforming

M. H. ORBAUGH, Electroforming Department
Bone Engineering Corporation, Glendale, California

Definitions

Electroforming may be defined as electrodeposition over the surface of a mold or matrix to a thickness of approximately 0.010 inch or more and subsequent removal of the mold from the plated shell. Perhaps the metallurgist or engineer would better appreciate a definition of electroforming as "cold casting". Still another definition of electroforming is the manufacture of articles or shapes by electrodeposition. This unique process is a new tool which, placed at the design engineer's disposal, makes possible the simplification of many construction problems.

Practically every plater has in his own shop all of the necessary equipment to do electroforming.

History

Originated over a hundred years ago by Jacobi for making electrotype printing plates, electroforming has slowly been expanded through the years by new applications.

Some of the earlier uses included the making of seamless copper tubes and sheet copper. Later applications were phonograph record masters, copper floats, copper caskets, fine mesh screens, searchlight reflectors, graining plates, and leather embossing dies. It is interesting to note that two old and well-established industries, phonograph record manufacture and electrotyping, are based on this process.

The trend to closer tolerances on precision parts, accelerated during the war, has given a marked impetus to electroforming. Its ability to produce high dimensional accuracy and fine internal surface finishes is becoming increasingly appreciated and was used to advantage in many war-born applications. The development of radar equipment necessitated the fabrication of precision tubing or wave guides, including complicated twists, bends, transitions from round to rectangular sections, tapered sections, magic T sections, and telescoped tubing, all requiring an internal dimensional accuracy of ± 0.001 inch or less and a smooth interior surface finish of the order of 3 to 5 micro-inch. Many such sections would have been impossible to fabricate by any other method. (See Figs. 1 and 2.)

Another ideal application of electroforming growing out of the war is in the manufacture of venturi tubes used in the jet-propulsion program (Fig. 3). Here again a highly finished and precise internal surface is required which, in most cases, cannot be duplicated qualitatively or cost-wise by any other method. Computing-pin cams and three-dimensional cams are other war-born electroforming developments which eliminate difficult and very expensive machining. Electroforming of plastic molds, experimented with prior to the war and only recently taken up again, promises to widen the field of plastic molding as well as offer considerable savings in the cost of making certain types of molds.

Materials

The metals generally applied in electroforming are copper, nickel, and iron. Where the function of the part requires it, chro-

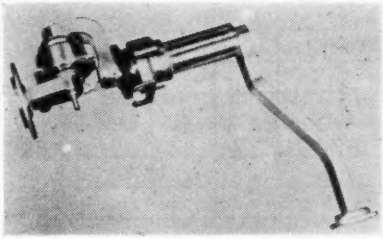


Fig. 1. Rotating-joint radar wave guide assembly with three electroformed sections

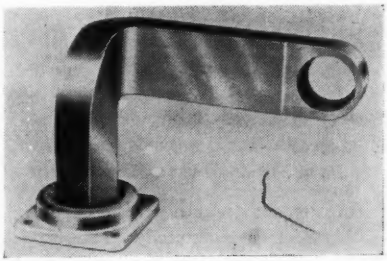


Fig 2. Radar wave guide section with double right-angle bend

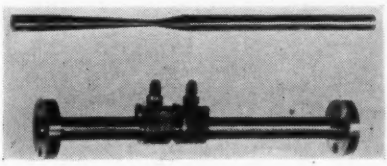


Fig. 3. Electroformed venturi meter at bottom, aluminum core used to electroform the inside contour of the tube at top

mium, silver, gold, or brass may also be incorporated in the electroformed structure. These metals, used singly or in combination, offer a wide selection to meet specific problems of corrosion, strength and wear. In general, the internal stresses in electroformed sections are low as compared to those present in many welded, forged, and cast sections, a fact which largely accounts for the superior dimensional accuracy made possible by the process. Moreover, the physical properties of electrodeposited metals are equal to and in many cases exceed those of the same metals in the cast, rolled, or forged condition.

Copper is deposited from the sulfate bath with a tensile strength of 20,000 to 50,000 psi. The practical deposition rate averages 0.002 to 0.003 inch per hour but can be stepped up, in certain cases, to as much as 0.012 inch per hour by the use of special equipment. This has been done in the manufacture of phonograph record masters. The softness of copper, 40 to 150 Brinell, somewhat limits its field of application.

Electroforming with iron is usually carried out in the ferrous chloride-calcium chloride bath at an average rate of 0.001 to 0.002 inch per hour. Electrolytic iron in the as-plated condition has a tensile strength of 50,000 psi, a Brinell hardness of 230 and an elongation of 15 per cent in 2 inches. In the fully annealed condition, the hardness drops to approximately 125 Brinell and the elongation rises to 30 per cent while the tensile strength remains essentially unchanged. It can be case carburized to a depth of 0.100 inch and heat treated to produce any desired hardness from 16 to 62 Rockwell C.

As a result of recent improvements in solution composition and control, nickel electroforming offers a much wider range of predetermined physical properties in the as-plated condition than do either copper or iron. Through the use of three basic types of nickel baths, metal can be deposited with a tensile strength ranging from 50,000 to 150,000 psi depending on the type of bath used and the operating conditions.

The so-called "soft bath" is the ordinary low *p*H Watts bath operated at 140° F and *p*H 2.0 to 2.5. It produces a deposit of 50,000 psi tensile strength, 150 Brinell hardness, and 30 per cent elongation in 2 inches. The practical rate of deposition for electroforming is 0.001 to 0.002 inch per hour.

The "medium hard nickel bath" is composed of nickel chloride and boric acid and is operated at a *p*H of 2.0 to 3.0 and temperature of 130° to 150° F. The deposit ranges from 100,000 to 120,000 psi in tensile strength with a corresponding elongation of 12 to 20 per cent and a hardness of 260 to 280 Brinell. This bath has been found to be especially well adapted to all-around electroforming since it combines

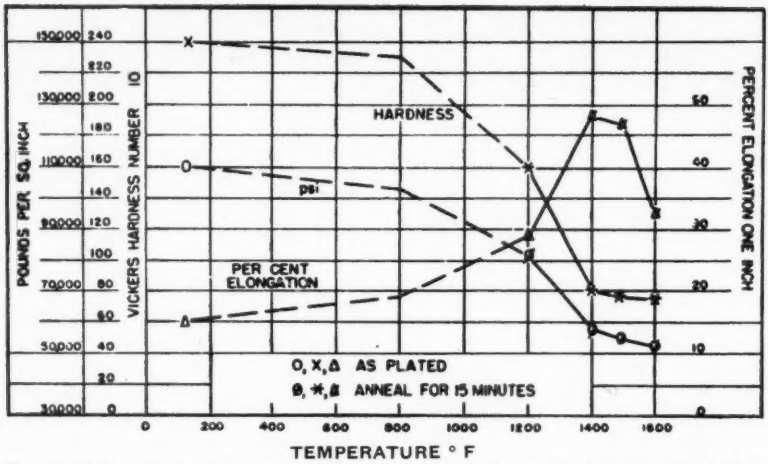


Fig. 4. Effect of annealing temperature on deposit from all-chloride nickel bath of pH = 2.0 at 55 asf

ability to produce excellent physical properties with high deposition rate, minimum of treeing and roughness, and ease of control. (See Figs. 4 and 5.)

Fatigue measurements recently made on electrolytic nickel established a fatigue limit for the "all chloride deposit" of 37,000 psi (100 million cycles). The yield point of this deposit is close to 80,000 psi.

The third basic type of nickel bath is the "double-salt hard bath" used for covering the range from 120,000 to 150,000 psi tensile strength and 28 to 45 Rockwell C hardness. By varying the temperature from 120° to 140° F, the *p*H from 5.2 to 5.9, and the current density from 20 to 50 asf, metal of any intermediate hardness and corresponding tensile strength can be deposited.

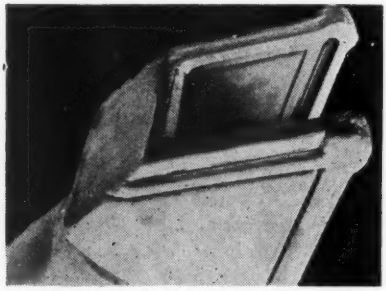


Fig. 5. Jet propulsion motor body requiring precise internal dimensions electroformed in all-chloride nickel bath. Wall thickness 5/8 inch, weight approximately 75 pounds

All three of the commonly electroformed metals, copper, iron and nickel, can be readily machined to a quality finish. Nickel and iron deposits are easily ground while copper deposits tend to load up the wheel. Electroformed material is seldom grown to a thickness exceeding 3/8 inch since, in most cases, this value is adequate; however, should the application require a heavier section, deposition can be continued to 1/2 inch or more. With thick deposits it is usually necessary to remove the part from the bath once or several times during the plating cycle to grind or machine off excessive roughness on projecting points.

Laminated deposits of two different metals such as nickel and iron are sometimes used to gain maximum strength and rigidity in an electroformed part. An example of this is the computing-pin cam mentioned earlier which requires high shear strength.

Applications

The electroforming process lends itself to mass production methods. Two questions are often asked concerning the process:

1. How expensive is it?
2. When and where is it used?

These questions can best be answered by saying that whenever fabrication of a part

becomes difficult, expensive, awkward, or impossible by the conventional method, it should be examined with a view to the possibility of electroforming. Very often electroforming provides a solution to the problem, and in such cases it is usually the least expensive method to use. Conversely, whenever the conventional method of fabrication permits the part to be made quickly, economically, and with no particular difficulty as to require dimensional and surface finish tolerances, electroforming probably cannot compete on a cost basis.

Equipment cost for an electroforming installation is considerably lower than that for machine tool operations producing the same dollar volume of work.

A typical application for which electroforming is indicated is the softball mold for imitation-leather softballs made of rubber. To put a natural-leather grained surface on the mold along with the stitching constitutes an extremely difficult and expensive hand-engraving operation. By electroforming techniques, the job involves no greater difficulty than would a smooth-surfaced handball mold, and a set of electroformed leather grain softball cavities can be made for a fraction of what it would cost to engrave the same mold by hand. Moreover, the electroformed cavities carry a natural-leather grained surface faithfully reproduced to the minutest detail from an actual leather covered ball used as a model, while hand engraved cavities would, at best, be very obvious imitations of a leather surface, lacking much of the natural detail. (See Fig. 6.)

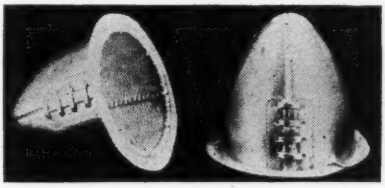


Fig. 6. Electroformed male mold for casting female wax patterns used in precision casting of football mold

The Process

In describing the various steps in the electroforming process in their proper order, one must start with the *matrix*. The matrix, or core, is the most important part of the entire process since it determines the shape, dimensional accuracy, and internal surface finish of the electroformed part and also greatly affects its cost. A wide variety of materials can be used as matrices such as wood, plastics, rubber, plaster of Paris, fusible alloys, aluminum, zinc, steel, and brass. They can be divided into two main groups—*the permanent type* which can be used for repeated runs and *the expendable type*. The permanent type group includes steel, brass, nickel, and stainless steel. The expendable group can be subdivided into dissolvable metals such as zinc and aluminum and fusible materials such as lead alloys and waxes.

In designing a matrix, one must give careful consideration to favoring the electroforming process in every detail of construction. Rounded contours are desirable wherever possible, sharp deep recesses should be avoided, slight tapers are advantageous where permanent cores must be withdrawn, and junction surfaces between sections of the core must be tight so that no visible crack is evident.

Matrices can be formed in several ways depending on the quantity, tolerances, shape, etc. Die, slush, and permanent mold castings, hubbing, and machining comprise the more common methods. When the number of parts is sufficiently large to justify the cost of a mold, cast matrices are the most economical. The highest degree of dimensional accuracy and surface finish is obtained in a die cast mold. Cast matrices are always of the expendable type and may be wax, plastic, zinc, aluminum, or fusible lead alloy.

If the required number of electroformed parts is comparatively small, usually less than one hundred, machining or hubbing of the cores is most economical since with a die the amortization cost per unit would be prohibitive. Machining and hubbing can be used on both the expendable and permanent type of core materials.

The next step is the proper *mounting of the matrix* for suspension in the plating bath. This must be done with a view towards securing the most uniform metal distribution possible and may include the mounting

of a target anode to achieve sufficient metal in some recessed portion. Guard wires are often attached to prevent undue build-up on edges or projections. Insulating shields are sometimes employed to lower the current density on projecting surfaces or to raise it in recessed areas. Areas of the core which must be protected from metal deposition are stopped off with insulating caps or lacquer at this time.

Treatment of the matrix before it is placed in the plating bath is next in order. This step is necessary to insure satisfactory and complete removal of the core material after electroforming, whether it be of the expendable or the permanent type. All treatments consist in the application of films which can be divided into three groups:

1. *Chemical films*—An oxide or other metal compound is formed on the core surface to prevent adhesion of the electrodeposited metal.

2. *Fusible-metal films*—These are used on permanent type matrices only and when heated above their melting point after electroforming provide clearance for easy withdrawal of the matrix. Plated tin or lead is used for this purpose in thickness from 0.0001 to 0.001 inch. Allowance is made in the core dimensions for the thickness of the fusible metal film.

3. *Organic films*—Lacquer, rubber, and carbon films are suitable for use on either metallic or non-conducting matrices. On the non-conducting matrix, the film provides not only the separating medium but the conducting surface for plating as well.

After the core has been mounted and properly treated, it is ready for the actual *electroforming operation*. This part of the process is essentially modern electroplating without, of course, the preparatory cleaning cycle. Agitation and constant filtration are required for quality results in most cases. Wetting agents are generally employed to eliminate pitting. Since the work usually remains in the bath for a matter of days, it becomes imperative to inspect the parts at regular intervals for replacement of built-up guard wires, smoothing unduly rough areas, or rotation of the part to equalize plate distribution as necessary. On the average, these maintenance operations are not required oftener than once every two days.

When the specified thickness of metal has been deposited, the object is removed from the plating tank and is ready for the *separation* step. This usually involves a simple lathe or band saw operation to free the edges so that the core can be melted out, dissolved out, or removed intact from the electroform, as the case may be.

The final step in the process is *finishing*. This operation comprises the removal of any residual core material from the inside surface of the electroformed part and the final machining of edges or outside surface as required. Where the increased rigidity of section supplied by the core is necessary for precise machining of the outside surface, the core is removed after machining.

Allied Processes

Two other uses of heavy metal deposition, not strictly electroforming but usually associated with it, are:

1. Resizing of worn or miss-machined parts, and

2. Heavy metal coating of non-conductors for industrial use.

Resizing—A worn or miss-machined part, representing a considerable amount of machine time, can often be salvaged by selective deposition of a suitable metal to such thickness that the originally undersized surface can be machined back to size. When the thickness required is much over 0.005 inch and the deposit must be machinable, chromium plate is generally not satisfactory and hard nickel or iron plate is used instead. The Rockwell C hardness obtained with deposits from the double salt hard nickel bath makes it especially suitable for such work.

Metal coating—Metal coating of non-conductors for industrial use has seen considerable development during the past three or four years. It differs from actual electroforming in that the non-conductive base is not subsequently removed from the deposited coating, and from ordinary plating of plastics in that the coating is 0.010 inch or more in thickness. Moreover, heavy coatings for industrial use are com-

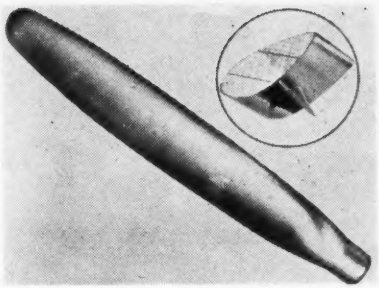


Fig. 7. Nickel coated wooden propeller blade. Average thickness of metal coating 0.015 inch, over-all bond strength 250 to 350 psi

monly bonded to their wood or plastic base with a tensile strength of better than 250 psi. Bakelite-impregnated plywood aircraft-antenna masts were coated with iron by the thousands during the war. Recent tests, still in progress, indicate that nickel coated wooden aircraft propellers offer several advantages over the conventional wood blade: greater strength, perfect weathering properties, increased efficiency, and smoother operation. (See Fig. 7.)

Conclusion

With the use of electroforming proved in so many applications during the war, it appears evident that electroforming has now taken its place among the recognized methods of metal fabrication. As design engineering groups become increasingly familiar with modern electroforming practice and learn how to take advantage of it, its field of usefulness will widen still further and the demand for electroformed material should rise at a rapid rate.

A. E. S. President Savage (second from left) is made a Knight of the Order of the (Chamber) Pot, the highest award bestowed by the Baltimore-Washington Branch. With him on this auspicious occasion are shown the Branch's Officers (from left to right): Treasurer Ray Stricklen, President Abner Brenner, Vice-President Robert Guerke, Secretary Grace Riddell, and Librarian N. E. Promisel

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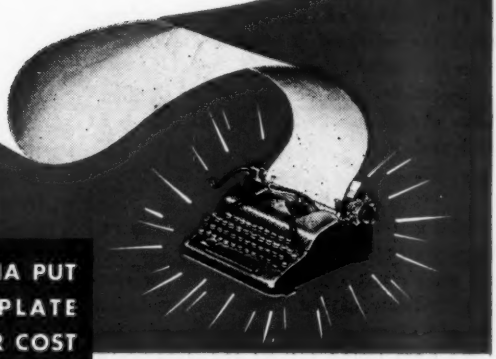

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BOLT TENSION vs. INSTALLATION TORQUE

OR ZINC AND CADMIUM PLATED NUTS, BOLTS AND WASHERS

WILBUR GROSS

Materials Laboratory Army Air Forces Material Command
Wright Field, Ohio

Purpose

The purpose of these tests was to determine the relationship between nut installation torques and the resulting tensile stresses in assemblies consisting of various combinations of cadmium and zinc plated nuts, bolts and washers.

Material

The materials included engine studs and requisite nuts 3/8"–24, submitted for tests by an aircraft engine manufacturing company. Some of the items were cadmium plated, others zinc plated. In addition, there were tested 1/2"–20 cadmium plated bolts, nuts and washers obtained from Wright Field stock. A required number of these parts were stripped and zinc plated at Wright Field for tests.

Test Procedure

The friction or contact surfaces (threads, washer and nut faces) of each assembly component were carefully cleaned by degreasing in naphtha and blowing dry with compressed air. Thus, the assemblies were tested only in the dry condition which is considered to be the most suitable basic condition for the determination of bolt stress vs. nut installation torque relationships. This procedure was in accordance with Production Engineering Section Directive "Cylinder Hold-Down Stud Failures, R–1830–43 Engines," dated 10 August 1943,

TABLE I
MATERIALS TESTED

ASEMBLY TYPE	PLATING OF COMPONENTS			TYPE OF NUTS	NUMBER OF ASSEMBLIES TESTED
	NUT	WASHER	STUD		
	3/8"–24	Engine Studs	and E. S. Nu	ts (AN365–624)	
CCC	Cd	Cd	Cd	W. F.* & Cham.	6
CCZ	Cd	Cd	Zn	W. F. & Cham.	5
CZC	Cd	Zn	Cd	W. F. & Cham.	6
ZCC	Zn	Cd	Cd	Chamfered	3
CZZ	Cd	Zn	Zn	W. F. & Cham.	4
ZCZ	Zn	Cd	Zn	Chamfered	7
ZZC	Zn	Zn	Cd	Chamfered	6
ZZZ	Zn	Zn	Zn	Chamfered	5
	AN8 Aircraft	Bolts (1/2"–2	0) and E. S.	Nuts (AN365–820)**	
CCC	Cd	Cd	Cd	Chamfered	5
ZCC	Zn	Cd	Cd	Chamfered	5

*W. F.–Washer faced.
**From Wright Field stock.

TABLE IV
AVERAGE TORQUE—TENSION PROPERTIES
OF ZINC AND CADMIUM PLATED NUT—WASHER—BOLT ASSEMBLIES

ASSEMBLY TYPE	NUT INSTALLATION TORQUE AT BOLT TENSION OF 40,000 PSI IN-LB	TORQUE RANGE AT 40,000 PSI IN-LB	MODULUS PSI PER IN-LB	TORQUE AT FAILURE IN-LB	NUMBER OF ASSEMBLIES TESTED
	3/8"-24 ENGINE STUDS				
CCC	277	195–335	155.1	980	6
CCZ	260	170–430	173.5	1015	5
CZC*	250	Low–240	180.7	1125	3
CZC**	435	High–460	95.8	1360	3
ZCC	295	265–310	153.7	915	3
CZZ	390	295–475	118.6, 84.6	1280	3
ZCZ	430	370–510	132.4, 96.6	1000	7
ZZC	368	240–410	144.5,101	1550	5
ZZZ	505	410–585	117.6,75.6	1405	5
	1/2"-20 AIRCRAFT BOLTS				
CCC	705	595–800	54.5	Not tested to failure	5
ZCC	735	660–815	54.5		5

*Washer faced nut
**Chamfered nut

which advised dry assembly for optimum results.

The tests were made in accordance with procedure previously developed as follows:

Assembly tests were made on from two to four nuts and bolts of each size and type to obtain wrench torque and resultant tension data over the full strength range from zero to the highest practicable point. Subsequently the extensometer was removed and the test was continued to failure in order that the maximum torque and the resulting type and location of fracture be obtained. The maximum bolt tensile loads were not determined.

By use of compression tubes as a means of obtaining the tensile loads developed in the bolts instead of taking deformation data directly on the shanks of the bolts as reported by the National Bureau of Standards in Research Paper No. 386, all possibility of errors resulting from possible yielding or plastic deformation in the bolts was eliminated.

Each bolt and nut was assembled through a compression tube of corresponding size with end-plate over either end and with a plain washer under the live, or data nut.

The bolt, nut, and tube thus assembled were mounted in an Olsen torsion testing

TABLE III

AVERAGE TORQUE-TENSION DATA
1/2"-20 AIRCRAFT NUTS, WASHERS & BOLTS

TENSILE STRESS AT BOLT ROOT PSI	ASSEMBLY TYPE TORQUE, INCH-POUNDS	
	CCC	ZCC
0	39	51
3,600	85	96
7,250	123	150
10,850	174	208
14,500	231	265
18,100	297	340
21,700	367	409
25,300	431	473
29,000	500	539
32,600	569	605
36,250	640	669
39,800	704	733
43,450	769	801
47,100	837	865
50,700	899	933
54,300	966	997
57,900	1029	1068
61,550	1092	1137
65,200	1157	1212
68,750	1221	1286
72,400	1293	1375
76,000	1316	1454

machine by means of which the wrench torque loads were applied to the nut in a series of regular increments. The torque was taken in inch-pounds as indicated on the machine while the corresponding increments of compressive deformation in the tube resulting from the tensile loads developed in the bolt were taken over a measured gage length by means of a standard Ewing extensometer assembled on the tube.

The series of tubes had been calibrated previously by means of load-deformation curves plotted from data taken by means of the same extensometers in compression tests in a universal testing machine adjusted to suitable capacity. The compressive loads in the tubes were obviously the same as the tensile loads in the bolts. Therefore, the bolt tensile loads producing the compressive deformations taken were read directly from the corresponding calibration table. The unit tensile stresses S in the bolt were then calculated on the root diameter of the bolt in the threaded section by the formula $S = W/a$, where W = tensile load in lb, a = bolt area in sq. in.

To prevent rotation with the nut an arm was clamped onto the tubes. The torque was applied to the nuts through standard wrench sockets.

The assemblies with their various combinations of zinc and cadmium plate are listed in Table I.

The average torque-tensile properties of the assemblies at a constant bolt tension of 40,000 psi are compared in Table IV. The particular bolt tension mentioned was chosen because it was considered safely below the proportional limit of the steel.

It will be noted from Table IV that there is a wide variation in test results. Since these tests involve the frictional

TABLE II
AVERAGE TORQUE-TENSION DATA
$\frac{3}{8}$"–24 NUTS, WASHERS AND ENGINE STUDS

TENSILE STRESS AT STUD ROOT PSI	ASSEMBLY TYPE								
	CCC	CCZ	CZC-A WASHER FACED NUT	CZC-B CHAMFERED NUT	ZCC	CZZ	ZCZ	ZZC	ZZZ
	TORQUE, INCH-POUNDS								
0	20	20	20	20	20	20	20	20	20
3,950	49	57	53	65	57	75	80	59	96
8,150	79	78	73	110	85	112	120	97	135
13,100	106	103	100	147	118	141	150	124	167
17,550	131	130	125	195	147	183	197	154	211
22,150	161	155	150	245	175	225	238	186	265
26,950	195	183	180	297	202	267	287	236	328
31,800	224	209	208	335	233	300	341	293	394
36,500	259	237	235	401	262	247	383	329	463
40,900	292	266	258	446	297	404	439	379	513
45,350	325	293	288	494	327	456	484	419	568
50,200	353	324	313	546	362	509	539	464	636
54,750	381	357	339	593	403	567	601	528	708
59,850	411	395	363	648	425	622	633	592	769
64,400	438	434	385	707	450	680	683	667	836
69,100	465	482	413	761	483	755	728	714	915
73,800	496	527	438	821	513	819	780	765	999
78,500	525	573	465	859	547	894	822	881	...
83,300	555	626	493	919	578	952	841	941	...
87,750	585	683	535	981	607	1035	869	963	...
92,700	619	741	583	1032	635	...	...	1034	...
97,000	650	822	630	1076	665	...	...	1085	...
102,000	684	...	690	1115	693	...	...	...	...
106,700	720	...	763	1153	725	...	...	...	...
111,000	761	...	840	....	758	...	...	...	...
115,800	801	...	...	....	803	...	...	...	...

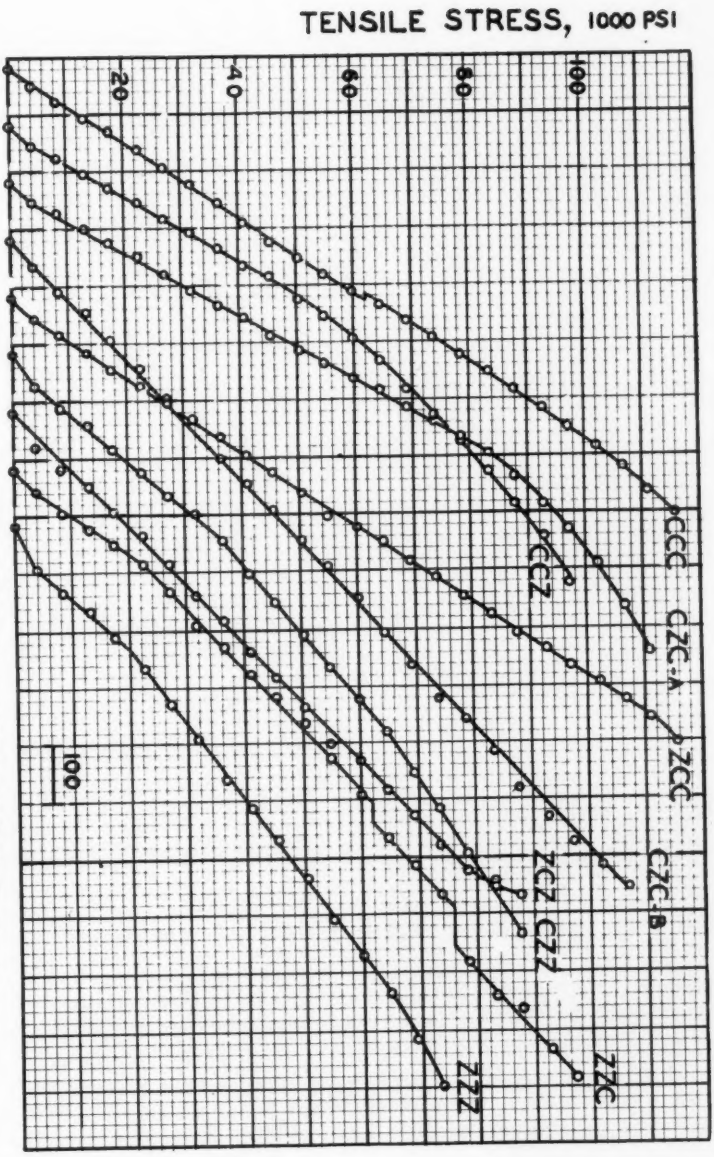

Fig. 1. Torque-tension data for 3/8"-24 Engine nuts, washers and studs

characteristics of high production components, there is probably sufficient variation in plating, surface finish and profile, tolerances and material, for reasonable expectation of this scatter.

1. Comparable torques are required for the installation of either cadmium or zinc plated aircraft nuts onto cadmium plated washers and bolts to produce a given bolt tension.

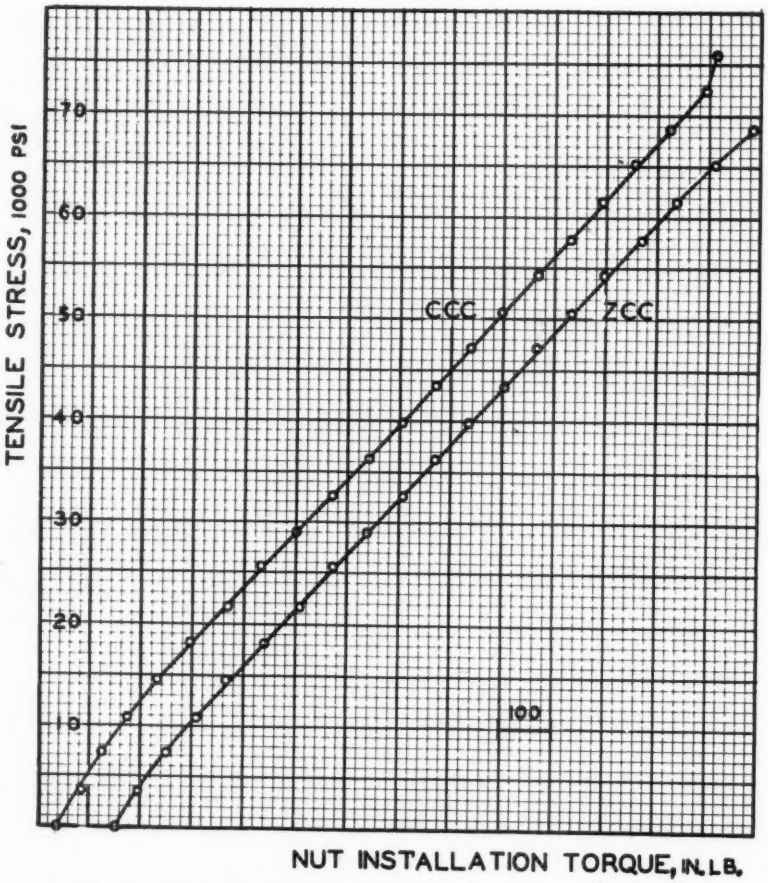

Fig. 2. Torque-tension data for 1/2"–20 Aircraft nuts, washers and bolts

RESULTS

The average stud stress vs. nut torque data for the several assemblies are presented in Tables II and III and have been plotted as shown in Figs. 1 and 2. For sake of clarity it was necessary to begin each curve at a different origin.

CONCLUSION

The following conclusions were drawn:

2. The torques needed to produce given tensile stresses in the bolt increase directly with the number of zinc plated parts in the assembly and the highest torque on the nut is required when nut, washer and bolt are all zinc plated.

3. Some tests indicated that greater torque may be required for the installation of chamfered-face than for washer-face nuts to produce a given bolt tension.

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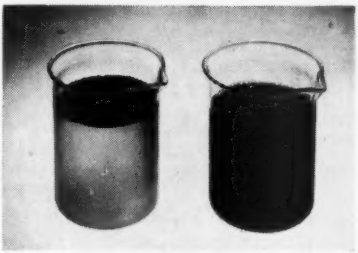

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PRINCIPLES OF INDUSTRIAL PROCESS VENTILATION

WILLIAM N. WITHERIDGE

Ventilation Consultant, General Motors Corporation—Detroit, Michigan

From the *Proceedings of the Inservice Training Course on Environmental Controls for Industrial Processes* given by the SCHOOL OF PUBLIC HEALTH, University of Michigan, October 2–4, 1945. Reprinted with the kind permission of the School.

Following World War I, the relatively young air conditioning industry began to equip manufacturing plants with effective temperature and humidity control for a rapidly expanding list of precision, hygroscopic and perishable products.

Following World War II, manufacturing industries are expected to demand more extensive control of air quality or air cleanliness, in addition to the necessary control of temperature and humidity.

The last decade, spanning the war years, has witnessed a tremendous advance in the art of controlling the concentration of dusts, fumes, mists, vapors and gases generated by industrial processes. The principle objectives of and reasons for this activity have been the prevention of occupational disease, atmospheric nuisance, explosion hazard and property damage. The term "Industrial Process Ventilation" is suggested here to designate the special phase of industrial air conditioning that deals with the mechanical control of all types of air contaminants traceable to industrial processes. It includes every kind of ventilating method from general space ventilation to highly specialized local exhaust systems with effective air cleaning equipment.

Classification of Industrial Process Ventilation

It is convenient to divide this subject according to the following brief classification:

A. General or space ventilation (dilution of air contaminant)
   1. Natural ventilation
   2. Mechanical supply with natural exhaust
   3. Mechanical exhaust with natural supply
   4. Mechanical supply and exhaust

B. Process enclosure ventilation (isolation and exhaust)
   1. Partial enclosure (painting, grinding, welding)
   2. Complete enclosure (sandblasting, metallizing)

C. Local exhaust ventilation (removal at the source)
   1. Updraft (canopy or curtain-type hoods)
   2. Sidedraft (backdraft or crossdraft bench hoods)
   3. Downd aft (bench or floor grilles)
   4. Lateral or slot-type exhaust for tanks and tables
   5. Unobstructed spot exhaust (flexible tube systems)
   6. Machinery exhaust enclosures (custom designed or "tailored" hoods for grinding, polishing, wood-working, textile machinery, stone crushing, screening, tumbling, etc.)

Fig. 1 illustrates a few of the basic types of local ventilating devices. Although the above classification separates process enclosures from local exhaust hoods, such items as spray booths, grinding booths and welding booths qualify under both divisions B and C. Booths large enough for men to work inside, with or without respiratory protection, are preferably classified under B, while booths designed so that operators' work outside might be rated as local exhaust hoods.

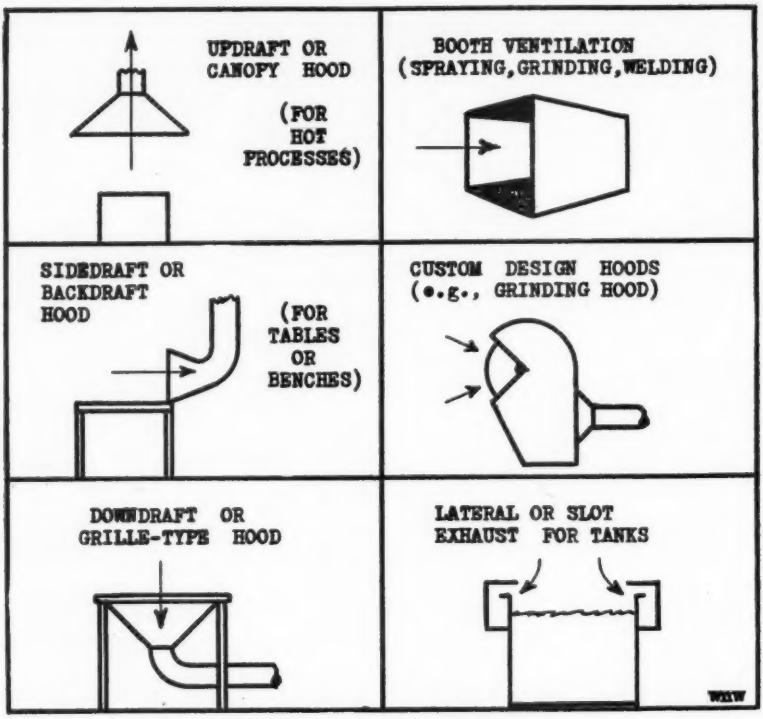

Fig. . Types of local ventilation

GENERAL VENTILATION

In the art of industrial process ventilation, the natural general ventilation achieved by correct design of industrial buildings for hot, humid and dusty operations has to some extent evolved into the highly effective local exhaust hoods in current use. Local ventilation can prevent the spread of air contaminants to the building atmosphere with surprisingly small flow of air in comparison with the air volumes necessarily circulated by general ventilation systems, natural or mechanical. In spite of this characteristic air conservation by local ventilation, there are highly persuasive reasons why general ventilation still is selected by many industrial managements:

1. Simplicity and economy of natural general ventilation
2. Relatively low first cost of mechanical general ventilation
3. Absence of interference with manufacturing operations
4. Flexibility in plants with constantly changing layouts
5. Existence of contaminating processes throughout entire plant
6. Desire for large volumes of air circulation in hot weather
7. Discovery that local exhaust systems do not eliminate the necessity for supplying large volumes of heated air in the wintertime to replace that escaping from loosely constructed buildings by exfiltration, and that such volumes of air may be more than ample to control process air contaminants by dilution if means are provided to disperse the contaminants in the immediate vicinity of the workers.

General Ventilation Specifications

There are in current use the following methods of specifying general or space ventilation rates:

1. Air changes per hour (Table I)

TABLE I
GENERAL VENTILATION IN TERMS OF AIR CHANGES

TYPE OF ROOM OR BUILDING PUBLIC AND INDUSTRIAL	AIR CHANGES PER HOUR		MINUTES PER AIR CHANGE	
	LOW	HIGH	SLOW	FAST
Auditoriums; assembly halls	4	30	15	2
Bakeries	10	60	6	1
Boiler rooms; engine rooms	4	60	15	1
Corridors; hallways; lobbies	1	10	60	6
Dairies; creameries	5	30	12	2
Foundries, ferrous	4	30	15	2
Foundries, non-ferrous	6	60	10	1
Garages, storage and parking	3	20	20	3
Garages, repair	6	30	10	2
Hospitals, ordinary	2	15	30	4
Kitchens, commercial	10	60	6	1
Laboratories, chemical	6	30	10	2
Laundries; pressing shops	10	120	6	½
Locker rooms	2	15	30	4
Machine shops	3	20	20	3
Offices, general and private	2	30	30	2
Restaurants; cafeterias	4	30	15	2
Residences (excluding kitchen)	1	6	60	10
Retail stores	6	20	10	3
Smoking rooms; lodge rooms	10	60	6	1
Toilets; bathrooms	10	30	6	2
Waiting rooms; lounges	3	10	20	6
Warehouses	1	6	60	10

2. Minutes per air change (Table I)
3. Airflow rate in cubic feet per minute per square foot of floor area (Table II)
4. Airflow rate in cubic feet per minute per capita (Table III)
5. Total airflow rate in cubic feet per minute as determined by air contaminant dilution computations (Table IV)

The fifth method is best for estimating the ventilation required to control air contaminants, but with a few exceptions, its application by designers has not yet extended beyond solvent vapor problems.

The following example will serve to illustrate the interrelationships between the first four methods of specifying space ventilation. Assume a classroom with the following dimensions: 10-foot ceiling, 15 square feet of floor per person, 150 cubic feet of space per person. The following ventilation

TABLE II
GENERAL VENTILATION RATES BASED ON FLOOR AREA

TYPE OF ROOM OR BUILDING	CFM/SQ. FT. FLOOR AREA
Human occupancy; space over 800 cubic feet per person	0.5
General industrial buildings having no localized sources of unhealthful, irritating, flammable or explosive air contaminants	1
ASHVE recommended rate for storage garages, mechanically ventilated with either supplied or exhausted air	1
Workrooms containing "heated surfaces" (AFA)	2
Small rooms with heavy smoking	3
Small congested kitchens	10
Enclosures or booths for arc welding	50
Rooms for abrasive blasting or metal spraying, supplied-air helmets required for workers	100

rates are identical:

1. 12 air changes per hour (60/5)
2. 5 minutes per air change (150/30)
3. 2 cfm per square foot of floor (30/15)
4. 120 cubic feet per hour (cfh) per square foot of floor (12 x 10)
5. 30 cfm per person
6. 1800 cfh per person (12 x 150)

The wide range of values in Table I makes it evident that gross errors are apt to occur in the absence of experienced judgment. General ventilation estimates should always be checked by at least one other method of computation if alternate data are available.

"Effective" Specific Gravity

It is frequently stated that gases or vapors heavier than air should be ventilated downward and those lighter than air should be removed from the room by updraft methods.

Experience indicates that it is quite important to consider the distribution, concentration and temperature of the gas or vapor in the air before drawing any conclusion about the relative merits of updraft and downdraft systems of ventilation and especially about general versus space ventilation.

Assume for example that the air contains a vapor with a specific gravity of 5.0 in a concentration of 1 per cent or 10,000 parts of vapor per million parts of air and that the vapor is well mixed with the air in the ventilated area due to drafts, convection currents and plant activity. One may then calculate the "effective" specific gravity of the mixture to be $0.99 \times 1.0 + 0.01 \times 5.0 = 1.04$. Therefore in relation to the incoming clean air, the mixture would have a tendency to move downward which should be expressed by the ratio 104/100 instead of 5/1 as is frequently implied. This means that in industry, the effects of drafts, window ventilation, traffic disturbances or process heat can easily dwarf into insignificance the effect of specific gravity.

Cleaning or degreasing liquids used on tables or in fairly stationary locations can be exhausted from the area by sufficient downdraft grille ventilation independently of whether the vapors are heavier or lighter than air. Updraft or backdraft hood ventilation is also practical if the correct amount of air is removed according to the distance of

TABLE III
GENERAL VENTILATION ON A PER CAPITA BASIS

CONDITION	CFM/PERSON
To maintain indoor oxygen at 20.0 per cent	2
Natural ventilation rate in 500 cu. ft. space	5
Minimum for body odor control	10
Minimum for tobacco odor control	15
To maintain indoor carbon dioxide at 0.10 per cent	20
For control of moderate smoking	25
Classic rate for schoolrooms	30
For control of heavy smoking	40
For heavy smoking in small rooms	50

The mathematics of the air-change method assumes that air distribution is uniform throughout the space so that all parts of the room or building are ventilated at the same rate. In practice such ideal distribution is rarely achieved.

General Ventilation for the Control of Solvent Vapors

General ventilation is occasionally the only practical method of controlling solvent vapors arising from industrial operations covering large areas of a plant. Ventilation requirements are based on the volumes of air needed to dilute the vapor concentration to a safe or satisfactory level. Requirements for the prevention of illness, intoxication or occupational disease usually are greater or more exacting than the requirements for fire prevention. Table IV demonstrates that air volumes for the protection of health range from 5 to 100 times the air volumes necessary for fire prevention.

TABLE IV
GENERAL VENTILATION REQUIREMENTS FOR THE CONTROL OF SOLVENT VAPORS

Air volumes are based on quantities of solvent evaporating into the workroom. Quantities of air required per minute or per hour must be determined by estimating the solvent losses in pints per minute or per hour

LIQUID		REQUIREMENTS FOR HEALTH		REQUIREMENTS FOR FIRE PREVENTION	
CHEMICAL NAME	Cu. ft. of vapor per pint of liquid at 70° F	Satisfactory concentration for human exposure during 8-hour day, ppm*	Cu. ft. of air required for each pint of liquid evaporated (to nearest 1000)	Allowable concentration for fire safety = 1/5 lower explosive limit ppm	Cu. ft. of air required for each pint of liquid evaporated (to nearest 100)
Acetone	5.5	500	11,000	5,000	1,100
Amyl acetate	2.7	100	27,000	2,200	1,200
Benzene	4.6	75	61,000	2,800	1,600
Butyl acetate	3.1	100	31,000	3,400	900
Carbon disulfide	6.7	20	335,000	2,400	2,800
Carbon tetrachloride	4.2	25	168,000	non-flammable	....
Diethyl ether	3.9	500	20,000	3,600	1,100
Ethyl acetate	4.1	100	41,000	4,400	900
Ethylene dichloride	5.1	100	51,000	12,400	400
Gasoline or naphtha	abt. 3.0	500	6,000	2,800	1,100
Methyl alcohol	10.1	200	50,000	13,400	800
Toluene	3.8	200	19,000	2,600	1,500
Trichloroethylene	4.5	100	45,000	non-flammable	....
Turpentine	2.6	100	26,000	1,600	1,600
Xylene	3.3	100	33,000	2,200	1,500

*ppm = parts of vapor per million parts of air = cubic feet of vapor per million cubic feet of air, 1 per cent equals 10,000 ppm.

Warning: The above quantities apply only when uniform distribution of air supply exists throughout the workroom which is very difficult to achieve; they also require that the vapors are released uniformly throughout the room or space. It is recommended that at least twice the amounts of air given above be used to compensate for the non-uniformity of vapor and air supply distribution in a space ventilated by general methods. In other words, doubling the above air quantities would contemplate 50 per cent efficient distribution of general ventilation. In some cases, distribution is certainly only 25 per cent effective and then four times the above air volumes would be necessary.

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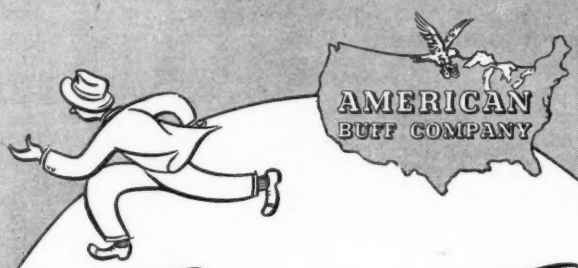
the hood from the point of operation. The important objection to updraft ventilation is NOT that it doesn't lift vapors that are heavier than air (which it does very well, in fact, at proper airflow rates), but that it may draw these vapors across the worker's breathing zone. However, if a sufficient volume of upward air movement is utilized, even the objection to drawing the contaminant across the breathing zone is "splitting hairs" when some operations are concerned.

Successive Ventilation

The air removed from an industrial plant frequently may be directed in a way that will provide both local and general ventilation. In fact, the air may be routed through several areas in succession, always in the direction of increasing air contamination, so long as the exhaust from one area is acceptable as the supply for the next area. The objective of successive ventilation is the saving of heat and air horsepower. For example, airflow may be:

From corridors to offices
From offices to manufacturing areas
From manufacturing areas to toilet rooms
From dining rooms to kitchens
From kitchens to locker rooms
From workrooms to local exhaust hoods

(*To be Continued*)



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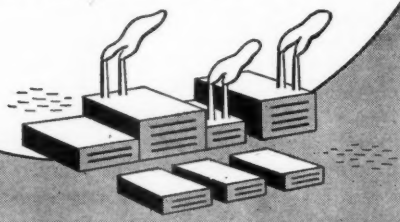

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POROSITY of ELECTRODEPOSITED METALS

A. E. S. Research Project No. 6

III. Critical Literature Review

N. THON
Project Director

E. T. ADDISON, JR.
Associate

Frick Chemical Laboratory, Princeton University, Princeton, N. J.

• ● •

(Continued from June)

Acknowledgment is due the Research Committee, Mr. E. T. Candee, American Brass Company, Chairman; the Research Directing Sub-Committee, Dr. Richard M. Wick, Bethlehem Steel Corporation, and Dr. Louis Weisberg, Consulting Chemist, New York City, Chairman and Vice-Chairman respectively; and the Project Sub-Committee, Dr. W. A. Wesley, The International Nickel Company, Chairman, Dr. B. Egeberg, International Silver Company, and Dr. Robert M. Burns, Bell Telephone Laboratories, Inc., for their contribution to this project.

3C. Methods of Determination of Total Porosity

$3C_1$. Chemical Methods

[$3C_1$.1] With chemical reagents attacking the base metal at pores and presumed to be without action on the material of the deposits, if the reaction results in soluble products, their amount can be estimated quantitatively in solution and thus give an accurate indication of total porosity. However, even if it is directly demonstrated, as it should be, that such methods do not cause new pores to be formed, they involve no imaginable valid end-point inasmuch as, in principle, the action can be prolonged or curtailed at will; the high accuracy of the estimation is offset by utter arbitrariness in the duration of the exposure which deprives the results of any absolute meaning. Nonetheless, the methods may have some value on a comparative scale and have been used to some extent, a constant time of exposure being chosen arbitrarily. Under such conditions, results are determined by the degree of porosity as well as the rate of penetration of the reagent into pores and the rate of effusion of the soluble products from pores; a more informative picture might be gained from comparative determinations of the amount of products as a function of time, but this does not seem to have received any attention as yet. Obviously, a great many safe reactions of this type can be devised. Practically, they offer the advantage of accurate and often rapid estimation and avoid the tedious, often impracticable and always highly arbitrary count of spots (222).

[$3C_1$.2] As an example (187), *tin deposits on iron* were tested by immersion for 15 minutes in a solution containing, per liter, 20 g ammonium thiocyanate, 10 g glacial acetic acid, 10 g 20-volume hydrogen peroxide; edges of the sample are stopped off with paraffin or another suitable wax. The amount of iron dissolved is estimated col-

orimetrically (red coloration); it varies, after the 15 minutes, with the amount of thiocyanate and of acetic acid in the reagent but is less dependent on the amount of hydrogen peroxide. As an indication, with tin thicknesses of 0.000015, 0.000024, 0.00006, and 0.00015 inch, the iron dissolved amounted to 2.5, 1.7, 0.7, and less than 0.1 mg/sq.dm., respectively; figures for hot-dip and for electrodeposited tin of same thickness are very close; on a logarithmic scale, the relationship is linear. The test is reported to be used in practice (220). It should be stressed again that the decrease of the effect with increasing thickness may very well be due to diminishing rate of penetration and effusion and does not compellingly prove diminished porosity. On a very *thick silver deposit*, 0.142 mm, *on Armco iron*, a negative test for iron in solution after refluxing with 30 per cent hydrochloric acid for 96 hours, neutralizing the solution with ammonia, oxidizing with hydrogen peroxide, and treating with ammonium thiocyanate (150) was considered evidence of total absence of porosity at that thickness, in agreement with the ferroxyl test [$3B_1.8$]; no silver is said to have gone into solution.

[$3C_1.3$] Another example is (123) the ten-minute immersion in a 1 per cent ammonia, 2 per cent ammonium persulfate reagent used on deposits of *nickel and* of *tin on copper;* its permissibility needs confirmation. At thicknesses about 4.5 g/sq.m. (0.000024 inch), the ten-minute porosity of bright tin deposits was found to be about half that of dull tin. Bright nickel deposits, 1.83 and 3.65 g/sq.m. (0.0000081 and 0.0000162 inch) thick, are found to be about 5 times less porous than dull nickel of same thickness. This finding, if authentic, would reveal a striking non-consistency, an inverse rather than direct relation between porosities and corrodibilities in salt spray [$3B_6.37$]: the point is worth stressing. For the rejected "Frigidaire" test, see [$3B_3.22$].

[$3C_1.4$] A particular type of total porosity test (74), applied to deposits of *chromium on brass*, uses no external reagent but is based on the marked difference of vapor pressures of base metal and deposit. On heating in vacuo, the zinc in the brass evaporates and diffuses through pores in the chromium. Porosity is inferred from the amount of zinc diffused; it is found to decrease with increasing thickness of the deposit and to parallel the indications of the rough nitric acid dip test.

3C2. Physical Methods

[$3C_2.5$] An ideal total porosity method would be one that avoided both external reagents and alterations in the base metal and derived the porosity from purely physical behavior and properties, mechanical, optical, electrical. At this stage only a few hints are available in this direction. Hardness of metals, deduced from the damping of a pendulum supported by the given material, has been linked with interstitial, i. e., porous structure in some recent Russian work on electrocapillarity of solid bodies (Rebinder, 1944, 1945), but no definite relationship is apparent. Findings of increased electrical resistivity with decrease of thickness of thinnest electrolytic nickel foils* may or may not be related to porous structure. It is to be feared that deductions of porosity from physical properties will of necessity involve debatable hypothetical assumptions.

[$3C_2.6$] Thus on deposits of *nickel and* of *tin on copper*, a very nearly linear relationship was found to exist (133, 190) between total porosity as determined by the same author chemically [$3C_1.3$] and inverse surface brightness measured with the aid of a photocell from diffuse reflection of light at angles symmetrically spread around the specularly reflecting angle, at 45° incidence, and expressed by the half-width of the angular reflected light intensity distribution curve. Whether this remarkable parallelism actually warrants generalization and use of inverse optical surface brightness as directly indicative of relative porosity at equal thickness—variation with thickness being obviously unapproachable by this method—is yet to be determined.

[$3C_2.7$] Permeability to non-destructive

*R. C. L. Bozworth, Trans. Faraday Soc. *30*, 549–554 (1934), who also describes techniques of removing thin nickel deposits from stainless steel.

gases of deposits separated from their base through intentional impairment of adhesion [3A.4] may be an ideal measure of total porosity as this method permits comparisons in the steady state. So far, it has been applied to sprayed coatings (101, 149) of various metals, zinc, lead, copper, aluminum, monel, iron. The reciprocal porosity is defined as the number of seconds necessary for 1 liter of air at 15° C and 1 atmosphere to permeate through 1 sq.cm. of film; the apparatus involves a compressed air tank, the membrane holder, and a graduated measuring tube in which the incoming air displaces water. Extension of measurement of the stationary rate of permeation to electrodeposits is clearly indicated.

[3C$_2$.8] A much more sensitive procedure, which avoids differences of pressure on both sides of the film, is based (218) on the use of radon (radium emanation) as the permeating gas; the amount of gas diffusing through pores is determined by usual radioactive measurement methods.

3D. Correlation between Porosity and Corrosion Exposure Tests

3D$_1$. Correlation Between Porosity Tests

[3D$_1$.1] Correct porosity testing methods should be expected to give quantitatively identical indications for similar deposits within reasonable limits of accuracy. Disregarding provenly objectionable methods and such purely coincidental and non-significant correlations as that between the old ferroxyl and the 100-hours' salt spray tests, both of them corrosive [3B$_7$.37], one still fails to find anything resembling quantitative agreement between tests that are safe or very likely safe from the point of view of reagent corrosiveness. The two-stage ferroxyl print method and the hot water test have been compared (154) on identical *nickel deposits on cold rolled steel.* Up to 0.0005 inch, the former reveals much higher numbers of pores than the latter, on thinnest deposits about 10 times more. The decrease of the number with increasing thickness, quite sharp with ferroxyl, is scarcely shown if at all in hot water; as an example, averaging three tests where the spread is reasonable, one has with thicknesses of 0.00010, 0.00025, and 0.00050 inch, with ferroxyl 100–200, 81, and 30 pores, respectively, with hot water, 14, 22 (!), and 9 pores. With 0.00075 inch and up, only 1 to 3 pores are found and comparisons are senseless. At each thickness, the deposit being on a cold rolled basis metal, there is a striking difference of spot numbers between the two sides; this difference, as far as can be judged from the scant material, seems to be more pronouncedly revealed with ferroxyl than with hot water; thus at 0.0001 inch one has on the two sides 100 to 200 and 7 spots with ferroxyl, 14 and 9 with hot water; parenthetically, averaging counts so widely divergent, as was done in the original, seems devoid of meaning.

[3D$_1$.2] Comparison of the same two-stage ferroxyl print method and the hot water test on deposits of *silver on iron* (143) again shows 3 to 7 times higher counts with the former in 0.0001 inch deposits; variations with basis metal lots are in the same order with either test, for example, 187, 635, and 850 spots per sq.dm. with ferroxyl, 66, 86, and 290 with hot water; at 0.0005 inch, spots are too few for comparisons to have meaning. The picture is completely reversed and considerably complicated in the presence of an intermediate layer of *nickel between the steel base and the* outer *silver deposit*, it being understood that either test of course is only supposed to indicate pores reaching down to the base through both silver and nickel. Hot water gives much higher counts throughout; except with the thinnest, 0.0001 inch, intermediate nickel layer where the hot-water rust spot count decreases uniformly with increasing thickness of the silver deposit, with nickel thicknesses of 0.0002, 0.0005 and 0.001 inch the hot water test indicates, first an increase, then a maximum (at 0.0001 to 0.0002 inch) and finally a decline of porosity with increasing silver thickness. With ferroxyl, on the contrary, one finds generally a uniform, even though somewhat erratic, decrease. In terms of increasing thickness of the nickel undercoat from 0.0001 to 0.001 inch, ferroxyl shows decreasing porosities of silver at any thickness of that deposit; however, with hot water this holds only for the thinnest silver deposits, 0.00001 inch, whereas for 0.0001 to 0.0002 inch silver, porosity is maximum

somewhere around 0.0002 to 0.0005 inch nickel. What, if anything, this means is far from clear; it is recorded here as a probable, unexplained methodological peculiarity of the test rather than an objective finding on porosity. Not only are the numerical indications of the two tests uncorrelated, but there is also no consistency in the shape of the phenomena shown by the two methods.

[$3D_1.3$] As has been illustrated in the foregoing two paragraphs, porosity tests cannot even be validly arranged in a fixed order of "efficacy", meaning that it cannot be said of one test that it will generally give higher counts under *any* circumstances than another method; more likely than not this will depend on particular conditions of application, and hardly any predictions can be made as long as so little is known of the mode of action of the various porosity reagents and the probably specific behavior of each of them toward particular types of pores. Experimental work pursuing the object of or involving systematic comparisons between porosity tests has been all too scarce so far. In particular, inferences have mostly been drawn from just a few tests, often involving very low spot counts where reproducibility and accuracy disappear altogether; reliable conclusions can only be drawn *statistically* by averaging very abundant experimental material, but such data have not yet been made available in any case. Very roughly, the majority of authors assert, on the basis of relatively sparing data, some sort of parallelism between indications of various porosity tests—mostly so chosen as to best approximate parallelism—but nowhere is it justifiably claimed that reasonably coincident counts can be obtained with different test methods. It is mostly found that the different methods when applied to identical material place its porosities in qualitatively the same order. This, as far as it is true, applies only to variation of porosity with thickness of the deposit as pointed out also by (194); no data are available which would warrant the same statement of parallelism in terms of conditions of the electrolysis, state of the base metal surface, grain structure of the deposit, etc.; with respect to such elements, the problem of correlation between different porosity testing methods remains yet to be investigated, once the methods have been checked and cleared.

$3D_2$. Porosity Tests and Corrosion on Exposure

[$3D_2.4$] On the twofold assumption that corrosion on exposure to various atmospheres occurs predominantly at pores in the protective deposit and that the porosity testing methods used indicate the actual porosity or a magnitude directly related thereto, a correlation should exist between the two tests. Search for such parallelism has been conducted quite extensively. Unfortunately, since the data on porosity underlying most of this work have been obtained by methods now recognized as objectionable and unsafe and hence only a small fraction is the result of meaningful tests, the conclusions arrived at are dubious; there is no wonder, too, if they are widely conflicting. The question proposed is whether or, more precisely, to what extent long-time corrosion on exposure to a given atmosphere occurs through attack at pores and how far it is due to destructive action on normal, sound areas of the deposit; correct answers can only be derived from a reliable knowledge of at least the *relative* true porosities of the deposits compared from the point of view of their behavior towards exposure corrosion—for example, identical deposits of varying thicknesses or deposits of same thickness but different grain structure, hardness, brightness, etc.; only with such a relative scale of true porosities can it be determined whether or how far outdoor corrosion is directly related to porosity. The material on long-time run exposure corrosion is abundant and on the whole more consistent than the data on "accelerated tests" (216) and, inasmuch as it involves no hypothetical interpretation, is immutable. The corresponding data on relative porosities of the deposits compared in exposure, however, are yet to be gained for the most part.

[$3D_2.5$] Existence of a direct correlation between ferroxyl and 100-hour salt spray porosity on one hand and corrosion in outdoor exposure on the other has been asserted in the case of *nickel plated steel* (31,

83) but was not confirmed in other quarters (66). For deposits of copper-nickel-chromium on steel polished with various abrasive grain sizes, outdoor exposure showed no significant correlation (186) with either ferroxyl, hot water, salt spray, or moisture condensation tests and none with the grade of polishing material used. On the other hand, *chromium deposits on steel* (65) are stated to behave in outdoor exposure*, with regard to the fraction of surface corroded, parallel to their Dubpernell test porosity which actually only reveals authentically original pores [$3B_3$.13] even though only an unknown fraction thereof; it is remarkable that a direct correlation is reported where the porosity has been demonstrated by a definitely non-corrosive method. Pores in 0.005 inch *lead coatings* are said not to be inimical (205) as they tend to self-plugging by corrosion products (200). Electrographic porosity patterns of lead-coated steel could not successfully be correlated with outdoor service resistance (219); as a result of failure to reproduce in the atmosphere the pore pattern previously obtained in the porosity test, it is surmised that "a considerable number of pores originally present actually closed up as a result of the electrochemical process, in other words, self-healing took place". Inadequacy of the test method is another possibility. Both natural and artificially produced porosity in *tin deposits on iron* sheet is reported (218 bis) to have been found unrelated, after forming, to corrosion by acidic foodstuffs; the thought is expressed "that there are many causes of porosity in tin coatings, only a few of which are very important from the corrosion viewpoint, that there is no very satisfactory way of distinguishing between them, and that indications are that porosity is more nearly a result of conditions causing low corrosion resistance rather than the primary cause itself". There can be no doubt, indeed, but that different types of pores influence corrodibility in different ways and that much more must become known about the performance and interpretation of porosity tests before relations with exposure corrosion can be established. For *chromium on brass* with and without a nickel undercoat (183), see [4.3].

[$3D_2$.6] In anodic metal deposits, direct correlation between porosity and outdoor corrosion resistance is hardly expected. For *zinc deposits on iron*, results of the sodium hydroxide test [$3B_4$.27] and of atmospheric exposure are said not to be consistent (63). In marine atmosphere, protection is said to increase only up to a certain thickness of the zinc coating after which further increasing thickness is immaterial (30); this, of course, may be taken as an indication of the determining role of porosity. On the other hand, it is reported (225) that "a number of salt spray and atmospheric corrosion tests on coatings which were very porous even to the naked eye compared to coatings which were *believed*† to be non-porous, showed no difference in their protective value". The opinion is expressed that "pores in zinc coatings quickly fill up with corrosion products of the zinc and therefore corrosion ceases within the pores". An incidental drawback of non-porous zinc deposits is said to be imprisonment of hydrogen and consequent persistence of hydrogen embrittlement. In the case of *cadmium on steel*, coatings of equal thickness (0.00005 inch) but higher initial porosity as derived from the dilute hydrochloric acid test [$3B_4$.30] show in atmospheric exposure rust spots earlier (72), two weeks as against seven weeks, than less porous deposits. Some degree of correlation cannot be doubted, but the material is too scarce and conflicting to permit judgment.

4. RESULTS AND CONCLUSIONS OF POROSITY INVESTIGATIONS

[4.1] With regard to available numerical data on porosity of various metal deposits, it must be kept in mind that the major part of this material has been obtained with methods that are clearly recognized as destructive for the coating and that hardly any systematic determinations having been made so far with the newer, safe test methods. Even so, investigators were almost exclusively concerned with variation of porosity with thickness, and mostly only

*See footnote to [4.4].

†Italics by the reviewers.

with determining that minimum thickness at which the deposit appears "pore free" by the given testing procedure. Not only is there no indication whatever that the number of pores counted stands in any definite relation to the true porosity of the deposit, but in most cases it is even doubtful that what was counted were authentic, original pores. With that in mind, one will do well not to attach any absolute meaning, not even one of order of magnitude, to the figures quoted in the following.

[4.2] Findings on *nickel deposits on iron* can be summarized to the effect that porosity is found to decline sharply with increasing thickness; practical freedom from pores is variously reported to be attained at about from 0.001 to 0.002 inch (0.025 to 0.050 mm); the lower limit is found pore free with the two-stage ferroxyl print test, very nearly so with hot water (154). Compilation of previous results of ferroxyl and salt spray porosity tests from the literature can be represented in a diagram (224 bis) in which the number of spots per sq.dm. is plotted against thickness; the observed porosities lie in an area between two curves and fall with increasing thickness. Retranslating the graph into figures, one has the tabulation shown in Table I.

TABLE I

Summary of Ferroxyl and Salt Spray Porosity Tests on Nickel Deposits on Iron

Thickness		Pores per sq.dm.	
inches	mm	from	to
0.0001	0.0025	70	up
0.0002	0.005	50	up
0.0004	0.010	12	up
0.0006	0.015	0	160
0.0008	0.020	0	75
0.0010	0.025	0	35
0.0012	0.030	0	20
0.0014	0.035	0	10
0.0016	0.040	0	8
0.0020	0.050	0	5

In this table, "up" means that the ceiling is open, the shaded area extending as high as 240 pores per sq.dm. and possibly higher. It need not be pointed out how utterly disappointing the picture is; actually, it has been reluctantly adduced here only to illustrate that fact. Once more, the reader should be warned against attaching any significance to the figures, the more so as the counts would have been multiplied many times if a moderate magnification had been used [3A.2 (d)]. In particular, and this was ascertained (218) by microscopic inspection, there would still be tiny spots indicating pores at thicknesses tagged "pore free" without magnification; the "zero porosity" would be shifted to higher thicknesses.

[4.3] The same applies to a multitude of data on other deposits encountered in the literature. *Lead coatings on iron* are reported to be "pore free" at as thin as 0.00012 inch, "safe" at 0.00035 inch (67). Hot water tested *tin deposits* plated from acid 2-napthol gelatin baths at 20° C and under most favorable conditions—"good quality" base steel, freshly filtered still solution (freedom from slime), 10 asf —show some 2700 pores per sq.dm. at 0.00005 inch thickness and practically none at 0.0001 inch and up (118); an unfiltered bath gave on 0.0001 inch deposits 95 pores per sq.dm., and on "poor quality" steel sheet, 3200; with a much lower current density, 2.5 asf, as high as 10,000 pores per sq.dm. were counted on 0.0001 inch tin and only 8 on 0.00025 inch; elimination of addition agents raised the porosity sharply. *Bronze deposits* are stated to be porous (96) up to a thickness of 0.0003 inch only. For *silver on iron* (143, 163) see [$3D_1.2$]; porosity is mostly found to disappear at around 0.001 inch thickness. A salt spray investigation of *chromium coatings on brass* (183), consisting in determining the time for "first failure" and concluding that it is lengthened from 51 to 130 hours if a thin nickel undercoat is inserted, is hardly pertinent because in atmospheric exposure the life was 4 weeks against 28.

[4.4] The case of *chromium deposits* deserves to be singled out inasmuch as the findings are based on the non-destructive Dubpernell test [$3B_3.13$]. Within the limitation as to the fraction of pores responding to that test, it is generally found that porosity of chromium first decreases with increasing thickness and reaches a minimum above which it increases (34, 35, 52, 57, 65). However, this renewed increase in discontuity after a minimum has been reached is

not actually relevant to porosity in the electrodeposit because what happens in thicker chromium coatings is spontaneous stress-relieving cracking and is not pertinent to the original natural porous structure; this is borne out by the observation (57) that the degree of discontinuity in thicker deposits increases on standing, rapidly in the first 24 hours, then ever more slowly; cracking becomes more pronounced if the deposit is heated to 200° C. The minimum of "porosity" is said to occur at 50 mg/sq.dm. of chromium (65)* corresponding to a thickness of 0.000028 inch (0.0007 mm); elsewhere it is reported (34, 57) at 0.0005 mm (0.000020 inch); the agreement is not bad at all. The picture is, however, undoubtedly complicated by superposition at medium thicknesses of two distinct phenomena, actual porosity (without quotation marks) and discontinuities through cracking; hence, it cannot be asserted that the minimum "porosity" corresponds exactly to what in other metals would have been considered as disappearance of porosity; more likely than not, but for the overlapping by the cracking effect, porosity in this test would only disappear at higher thicknesses. The degree of porosity at its minimum varies (57) with conditions of deposition [4.6].

[4.5] Hardly any worthwhile data are available on porosities of *zinc and cadmium coatings;* they are mostly indirect, having been inferred from exposure tests which is by no means compelling. Films of cadmium, one-half to one-third less in thickness than a zinc film, are said to be less porous (25). See further [4.7].

[4.6] In terms of factors other than thickness—in particular conditions of electrolysis (composition of bath, current density, etc.), preparation of base metal surface, structural and mechanical character of the deposit—reports are as fragmentary as they are conflicting and unsatisfactory. The statements quoted in the following are all in need of check and verification. *Nickel deposits* are said to become more porous as the *p*H of the bath increases (27); deposits from chloride baths are no different from those produced in sulfate baths, therefore "porosity is not primarily dependent on bath composition" (156); a highly complicated sulfate-fluoride bath (88) is said to produce "pore-free" nickel; addition of oxidizing agents has no effect on porosity (129); deposits on a rough, polished surface are more porous than on a smooth surface (119); on the other hand, the grade of polishing material is found without effect (186); fine-grained deposits are roughly estimated to be less porous (8, 125); bright deposits of nickel and of *tin on copper* are distinctly less porous than dull ones (123, 133) (see [$3C_1.3$], [$3C_2.6$]). A many-staged alternately anodic and cathodic preparatory cycle is said to yield "pore-free" "thin" *nickel deposits* (70). Porosity of *silver deposits* decreases with increasing current density and with increasing free cyanide content (163); it is much less when silver is applied to the steel over a pore free copper coating than when produced over a copper strike; on the other hand, normal variations of current density are found to have no effect on the porosity of silver on steel (143); variations in the porosity of the deposits with the type and finish of the steel base are very pronounced (143). *Tin coatings on iron* (118) from acid baths are less porous with higher current densities; the effect of the quality of base metal is marked [4.3]. *Chromium deposits,* too, are stated to be less porous when produced at a high temperature (65° C) and corresponding high current density (56, 214); the "minimum porosity" is less at 65° C (higher current density) than at 45° C (57); increase in chromic acid content of the bath decreases the porosity of the coating (57). With the cathode moving, freedom from pores is attained at a thickness of 0.035 mm (0.0014 inch) as against 0.080 mm (0.0031 inch) with a stationary cathode (47). In *barrel deposition* there are many cases of 0.0001 inch thin deposits free from pores as against a required 0.0025–0.0030

*As mentioned under [$3D_2.5$], there is a remarkable parallelism between this test and outdoor exposure which also gives a minimum of corrosion at the same thickness of 50 mg/sq.dm.; however, in atmospheric exposure, there is also an initial maximum at 20 mg/sq.dm. which is absent in the porosity test and the meaning of which, if any, is unclear.

inch in still electrolysis (138); barreling closes pores by a cold working effect.

[4.7] In *zinc* deposited from sulfate baths, the "critical thickness" below which pores are "clearly discernible" is said to decrease with increasing current density and with higher *p*H (198). Porosity of *cadmium deposits* is reported to be unchanged despite a change of current density from 3.5 to 30 asf and to be unaffected by a change in cleaning processes prior to plating or by plating on dried instead of freshly washed and etched steel (72); cadmium from cyanide baths, 0.0003 inch thick, on machined cast steel is still porous whereas plate of the same thickness is pore free on rolled sheet steel.

[4.8] Perfect unanimity exists on one point only, namely, that in all cases porosity declines sharply with increasing thickness of the deposit and disappears above a certain thickness. The *actual*, ever-recurring *finding* of all tests heretofore applied is that the number of spots revealing individual pores or the amount of reaction products of the base metal in equal time intervals diminish with increasing thickness of deposit. Whether this is as stringently tantamount to the first sentence of this paragraph as is commonly taken for granted or the fact may mean something else instead will be examined in [5B].

5. CAUSES AND NATURE OF POROSITY

5A. Causes

[5A.1] Abundant experimental material leaves no doubt about the fact that the condition of the base metal surface is at least one of the important factors determining the porosity of the deposit; this will be referred to henceforth as *base-originating* porosity. There can further be no doubt that suspended matter in the electrolytic bath, insofar as it reaches the cathode and settles there, will exert the same kind of screening action on points of consecutive layers of the deposit as the originally underprivileged areas of the base and give rise to *suspension-originating* porosity. Pores of these and related origins, arising out of accidental obstacles to indiscriminately uniform deposition, whether they be at the very beginning or due to mechanical inclusions at later stages, can be described as *mechanical porosity*. Beyond that, as will be shown later on, there is ample evidence flowing from fundamental notions about the process of electrodeposition that porosity must be intrinsically linked with electrolytic growth; this type is best termed *intrinsic porosity;* contrary to the first class of pores which can be suppressed or reduced by base surface equipotentialization and electrolyte purification, intrinsic porosity cannot be eliminated or influenced by mechanical procedures. The idea of a twofold origin of porosity in electrodeposits is found expressed in the literature (153), speaking of "specific porosity, linked with crystal structure" and "induced porosity which depends on external conditions"; the former corresponds to our "intrinsic" porosity, the latter to our "mechanical" porosity.

[5A.2] Base-originating porosity of deposits on iron has from the very first been attributed to heterogeneities in the surface, as for example to graphitic and perlitic areas in cast iron (11), to sulfide segregations (16), etc. All imaginable factors apt to determine mechanical porosity are found enumerated and discussed in the very thorough study (129). Causes for failure of the deposit to grow over certain areas of the base metal are listed under five headings: 1. *Unequal deposition from the very beginning* of the electrolysis, certain points of the base being crystallographically preferred as "active centers" or nuclei for the formation of the first crystals of the deposit; any factor enhancing original heterogeneity in the base surface also accentuates the inequality in the rate of formation of the deposit. It is well known, particularly since the work of M. Volmer and his school on electrolytic crystal growth, that the alternative of whether subsequently discharged metal ions are to continue the growth of initially "sown" crystals or start new crystal nuclei is linked—being either determined or merely evidenced by it*—with the *polarization* of

*The much discussed problem of which is first, somewhat similar to the issue of relative priority of the hen and the egg, need not be considered here.

the particular electrodeposition process; polarization (other than diffusion-determined concentration polarization) or overvoltage* expresses the excess energy or energy of activation over which the metal ion is bound to pass between its arrival at the cathode and its final insertion at rest in the crystal lattice. Whenever the process is accompanied by low polarization, i. e., when its energy of activation is low, insertion of the ion will be strongly oriented by local potential differences in the base surface which may be due to chemical, crystallographic, or physical heterogeneities such as unequal stress. Such local potential differences become negligible at a high polarization (high energy of activation) of the deposition process itself, as for example in deposition from complex electrolyte solutions; in such cases base-originating porosity due to *electromotive* heterogeneity can not play a major role. . . . 2. *Local areas of poor electrical conductivity*—scale, slag, oxide, sulfide, phosphide, etc., or grease, abrasive particles, etc.,—left on the surface by pre-treatments which result in lower, or even zero, local current density and hence slower, or altogether absent, local deposition; this cause of porosity is evidently trivial . . . 3. *Loose particles* lodged on the base surface since its immersion in the electrolyte which give rise either to effect 1 or, which is more common, to the screening effect 2. Such particles may come from anode slimes, from the solution, from the material of the container, or from the base metal itself, in brief, from anywhere; the original discussion lists many possible sources, and there is no doubt that many more can be thought up; the same applies to the great variety of ways in which such particles can cause a discontinuity in the deposition and give rise to a pore. Interfering particles can reach the cathode and settle there accidentally, or by convection, or, most systematically, by *cataphoresis* if they carry a negative interface charge as is general with metal hydroxides and hydrated oxides; with elementary precautions taken to exclude gross and trivial sources of suspended matter, there remains the systematic alkalizing in the neighborhood of the cathode which results in precipitation and suspension of hydroxides and basic salts; that is where the bulk of suspended particles which are cataphoretically conveyed to the cathode is recruited; this point will be further developed in the following paragraphs. . . . 4. *Tiny gas bubbles* settling temporarily at a point of the cathode will evidently disrupt deposition at that point, particularly if trapped in a depression or fissure; the gas may be air dissolved in the electrolyte or, chiefly, hydrogen evolving in the electrolysis. With regard to this listing, it must be stressed that there is no evidence that increased hydrogen evolution results in increased porosity [4.6]; rather there seems to exist some evidence to the *contrary*. Pitting in nickel, which is undoubtedly linked with hydrogen evolution, is altogether unrelated to porosity as will be shown later [5B.3]; this factor seems to have been listed out of a concern not to omit anything and not on grounds of proven pertinence . . . 5. *Surface roughness* is directly related to the throwing power of the solution; on a rough surface, a high-throwing electrolyte will find depressions more easily than a lower-throwing one which may be unable to produce a deposit in recesses; the relatively low porosity of bronze deposits [4.3] produced in the high-throwing cuprous cyanide-sodium stannate bath as compared with the higher porosity of nickel is ascribed to the poorer throwing power of the latter bath; both the facts and the interpretation need to be confirmed.

[5A.3] It is evident that the foregoing analysis, following (219), of possible causes of mechanical porosity and the comments accompanying the various factors listed apply not only to the initial stages of the deposition and the effect of the base metal surface but are valid at all subsequent stages as well; this holds in particular for items 1 and 2, and for the role of precipitated suspended matter, item 3, insofar as it gives rise to effect 1 and particularly 2. The suspension-originating porosity is, in a way, intrinsic. Not only is insoluble basic matter

*This term, currently applied to evolution of hydrogen, is equally correct for all (non-diffusion) polarization of electrode processes including metal deposition.

formed in the bulk of the solution, but the "cathode film", the layer of electrolyte closely adjacent to the cathode, is subject to constant depletion of hydrogen cations and consequently to alkalizing; the *p*H is permanently higher around the cathode than in the bulk. That non-metallic basic matter is systematically included and built into the metal deposit is generally accepted; it is a distinctive feature of electrodeposited metal. That such unavoidable inclusions give rise to porosity is a certainty; the idea that such inclusions *are** porosity, in other words that pores in electrodeposits are not "empty", i. e. air or gas-filled, but, say, hydroxide-filled—which, by the way, would not detract from their dignity of pores—is legitimate. This latter point of view will be discussed and, it is hoped, dismissed under [5B.2] when the nature of porosity will be dealt with. As a cause of overall porosity, suspended particles undoubtedly play a role and are responsible for at least a fraction and a certain type of pores. On the other hand, it can be argued that their role cannot be decisive: inasmuch as the effect is continually present at all stages of the deposition no matter what the thickness already attained and by no means is confined to the initial stages of deposition on the base metal or to first layers, it ought to make itself felt at any stage, early or late; in other words, if suspended matter and basic inclusions played a prominent role as a cause of overall porosity, there would be no reason why it should decrease with increasing thickness—if it actually does decrease.†

[5A.4] The very mechanism of electrolytic growth, briefly sketched in [5A.2] under 1, underlies and *postulates* porous growth of the deposit even in the total absence of interfering non-metallic matter; that is what is meant by intrinsic or structural porosity. Insertion of metal ions into the crystal lattice is governed by transitions from higher to lowest energy levels over intermediate activation levels; metal ions are directed into their positions in crystals either already started or about to start at certain privileged points; there is no compulsion and no tendency to fill the space in an absolutely tight manner; from the point of view of pure stereometry, absolutely compact interlocking of individual crystals is not conceivable because in electrodeposition which takes place at low temperatures, far below the freezing points of the metals, crystals do not flow as readily and hence do not interlock as in crystallization from a melt.‡ This seems to us to be the main distinguishing feature between electrodeposition and crystallization on freezing. It involves, of *necessity*, systematic interstices or hollows, in other words, structural intrinsic porosity, in all electrodeposited metals. What's more, from this point of view, too, there is no reason why this porosity should in any way decrease with increasing thickness of the deposit. In fact, the reviewers' thesis is that it does not and that the apparent decrease in porosity with increasing thickness found in all tests heretofore applied is simulated by the very nature of the pores.

5B. Nature of Pores

[5B.1] Are thick deposits actually pore free? Egeberg (in discussion, 176) remarked that, in electroplaters' language, "pore-free" means no pores to the base metal, or that cross-section is small enough *to prevent penetration*¶ of the given reagent". This remark, fully subscribed to, calls for far-reaching extension. It having been shown that all porosity tests used heretofore must of necessity be curtailed arbitrarily, they obviously can only reveal pores into which the reagent has had *time* to penetrate; narrow and long pores will be penetrated at a

*See footnote to [3A.5].

†In connection with the role of inclusions of precipitated basic matter, investigations of porosity of deposits produced in non-aqueous solutions and in fused salts—no mention of which was found in the literature—might be of considerable interest.

‡Parenthetically, electrolytic tin deposits can be rendered less porous by reflowing by induction heating (201); cold working, of course, deforms and flows metal crystals and causes interstices to collapse, hence porosity is likely to disappaer as a result of cold working.

¶Italics by the reviewers.

much slower rate, and indications are that all porosity tests are stopped long before that happens. Furthermore, under [3A.4] it has been pointed out, by anticipation, that, beside the straight, perpendicular pores visible in transmitted light, there exist non-linear, non-perpendicular channels connecting the base with the outer surface along a winding or broken path. The proof is simple: nickel deposits, about 0.025 mm (0.001 inch) thick, on carbon steel were tested (218) with new, non-destructive ferroxyl reagents and, particularly on inspection under a binocular microscope, were found quite porous; identical deposits detached from stainless steel did not show one single transparent pore when viewed in transmitted light under the microscope. One can think of no reason why the non-adherent film should be *less* porous than an identical adherent deposit. It leaves one conclusion only, namely that *all* pores in the thick deposit are of the non-linear or non-perpendicular type; *some* of them, very likely only a very small fraction—the "easiest" ones—were detected by the chemical reagent, but the majority were not. Now, it is obvious that the thicker the deposit, the rarer must be the *exceptional* straight, perpendicular, short pores; there may be many of them in thin deposits, but as the deposit grows in thickness pores straggle and wind to an ever-increasing degree; there will be ever fewer pores that can be penetrated by the reagent fast enough; the test will fail to detect the ever-increasing numbers of pores. Inasmuch as both suspension-porosity and structural porosity occur at *any* stage and at *any* thickness, it appears highly probable from [3A.3, 4] that there exists in an electrodeposit a whole *network* of winding, branching, and communicating pores; a "pore" is but a string of interstices and follows generally a very complicated roundabout path; the probability of a more or less straight, easily penetrable channel is relatively slight and falls drastically with increasing thickness of the deposit. That is the answer proposed to the question formulated in [4.8]; the question at the outset of this paragraph is answered in the negative.

[5B.2] It could be argued that transmitted light opacity might indicate not non-linear pores but pores filled with non-metallic basic inclusions; this would be in line with the school of thought which identifies pores with inclusions [5A.3] and the role of porosity reagents with leaching out the basic products. This idea, however, can be dismissed because it cannot be reconciled with the fact that thinner deposits separated from their base do exhibit a great many transparent pores without any liquid reagent having been applied; that non-corrosive reagents which ought to be able to leach out non-metallic products fail to create new transparent pores; finally, that non-acidic, very nearly neutral and, in some cases, alkaline reagents are apt to detect pores. This, it is believed, disposes of the question left over from [5A.3]; suspended inclusions do provoke pores by poisoning* possibly active points and precluding sowing and forming new crystals in their neighborhood, but there is no evidence of pores being *filled* with such inclusions; there is evidence to the contrary.

[5B.3] It is worth stressing that *pitting* in nickel deposits has nothing to do with porosity. A pit, arising at a point where a hydrogen bubble has been preventing electrolysis and deposition for some time, is a depression in the surface. Observation under the microscope with porosity reagents on quite heavily pitted deposits showed that pores have no preference whatever for pits and are indifferently distributed over pitted and non-pitted areas. The observation (129) that addition or absence of an oxidizer – which counteracts pitting—has no effect on porosity bears it out.

[5B.4] The common doctrine of gradual closing of original pores as the deposit grows in thickness has elicited some interesting research on the mechanism by which pores are healed. Wesley (in discussion, 129) described an experiment in which holes of different small diameters ranging from 0.00088 to 0.01 inch (0.022 to 0.25 mm) were drilled in a gold-palladium disc and nickel was deposited electrolytically on one face of it; the rate of sealing of the holes was

*"Poisoning" is used here in the same sense as in catalysis.

observed by optical and chemical means, then the deposit stripped from the disc, and the experiment repeated with a greater thickness of deposit. Results showed that not even the smallest holes, 0.022 mm in diameter, were completely sealed by a nickel deposit of 0.001 inch (0.025 mm), but an 0.002 inch (0.05 mm) deposit closed holes of initial diameter of 0.0014 inch (0.0356 mm) or less. It was concluded that "nonconducting areas much smaller than 0.022 mm in diameter are capable of causing pores in a nickel deposit 0.001 inch thick merely by virtue of their lack of conductivity". The conclusion is, of course, correct as far as it goes; it should be borne in mind that disappearance of holes in transmitted light inspection does not necessarily indicate sealing of the pores; it may simply mean, in conformity with our representation, that on further growth in thickness pores cease to be straight and perpendicular and become winding channels, opaque in transmitted light and much less easily penetrable by chemical reagents. To the current representation of "healing" of initial pores by *sealing*, that is either by "plating over or plating into" (61)—the first mechanism being variously described as "bridging over", etc.,—one may add or substitute the mechanism of *masking* of pores by non-linear growth in depth.

[5B.5] In this connection, an experiment (154) is worth reporting in which an electrolytic nickel foil was treated with an iodine tincture reagent for several hours, resulting in only slight loss of weight but severe perforations. On adherent thin nickel deposits, the reagent produced no more spots than the non-corrosive two-stage ferroxyl print test; on thicker deposits it produced spots where the latter test failed to reveal any. It was concluded that pores present in the thin deposit had been bridged on further growth in thickness by very thin membranes and that these membranes break down under the action of what is apparently a mildly corrosive agent attacking the metal only at its *weakest* sound spots. Such sealing with precariously continuous thin films may, of course, occur but need not alter the general picture set forth in the foregoing.

[5B.6] This representation is also apt, on further study, to shed more light on the central problem of the relation between porosity and resistance to corrosion on exposure. The problem is by no means simple. On long-run exposure, extending over weeks, months, and years, pores of complicated shape that wind their way down to the base metal and are not revealed by accelerated porosity tests may well play a prominent role. Detection of this type of porosity and its evaluation and correlation with the rich experience on exposure corrosion is a task for the future.

(*To be continued*)

Porosity of Electrodeposited Metals

A CORRECTION

In the sixth line from the bottom of the second column of page 729 (June issue), the first complete word should be "acid-azo-α-napthylamine."

Third International Conference To Be Held In London, September 17th to 20th

The Council of the Electrodepositors. Technical Society is arranging to hold the first post-war International Conference on Electrodeposition—the third in this series to date—in London in September, 1947, instead of May 1-3 previously announced.

All sessions of the Conference will be held at the Hyde Park Hotel, Kensington, London, S. W. 1.

There has been encouraging overseas support for the Conference, and it is anticipated that there will be a good attendance of foreign visitors, including representatives from France, Holland, Italy, United States, Canada, Australia and India. Reports on the current state of electrodeposition in Germany, Switzerland, and Sweden will, *inter alia*, be presented.

Steps have been taken to reserve a limited number of rooms both at the Hyde Park Hotel and elsewhere in order to accommodate foreign and provincial visitors. Those wishing to take advantage of this service are advised to contact the Conference Secretary as early as possible in order that the necessary individual reservations may be carried out. Since it is likely that accommodation in London will be particularly difficult, the earliest intimation by those who desire bookings is obviously essential, and these again will be carried out in strict rotation to the limit of the accommodation which is available.

The provisional program includes the following:

WEDNESDAY, SEPTEMBER 17

2:00 P. M. to 5:00 P. M.—FIRST SESSION

Electrolytic Polishing of Metals

P. Jacquet (France), Electrolytic Polishing (Scientific Applications)

M. Halut (France), Electrolytic Polishing (Technical Applications)

H. C. J. Decker, A. P. L. Kuijef and J. M. Plunt (Holland), Some Special Applications of Electropolishing

P. Berger (Gt. Britain), Electrolytic Polishing of Brass Pressings

E. Farner (Gt. Britain), Motion Study and Training in Metal Polishing

5:30 P. M. to 8:00 P. M.—SECOND SESSION

Miscellaneous Processes and Reports

H. A. Holden (Gt. Britain), Chemical Treatments for Zinc Surfaces—A Review

H. E. Arblaster (Australia), Recent Work in Silver Plating in Australia

R. M. Wick (U. S. A.), American Electroplaters' Society Research Work

A. W. Wallbank and others (Gt. Britain), German Electroplating Practice

W. F. Coxon (Gt. Britain), Continental Trends in Metal Finishing—A Visitor's Impressions

J. Van Der Sommen (Holland), Title later

C. D. B. Williams (Gt. Britain), Porous Chromium Plating by the Van der Horst Process

THURSDAY, SEPTEMBER 18

10:00 A. M. to 1:00 P. M.—THIRD SESSION

Electrodeposition Processes

P. Baeyens (Holland), The Effect of Operating Conditions on the Throwing Power of Cyanide Cadmium Plating Solutions

S. Wernick and F. Willets (Gt. Britain), Electrodeposition of Nickel as a Manufacturing Operation

R. Piontelli and L. Canonica (Italy), Electrodeposition of Metals from Sulfanate Baths

R. R. Rogers and M. Boyd (Canada), Electrodeposition of Corrosion Resistant Metallic Coatings on Magnesium Alloys

A. Brenner (U. S. A.), The Electrodeposition of Alloys of Tungsten with Iron, Nickel and Cobalt

N. A. Tope (Gt. Britain), Experiences with Rochelle Salt Copper

2:30 P. M. to 5:00 P. M.—Fourth Session

Structure of Electrodeposits

R. Piontelli (Italy), On the Influence of the Basis Metal on the Electrodeposition of Metals

A. T. Steer (Gt. Britain), The Mechanism of the Exfoliation of Electrodeposited Surfaces

U. R. Evans (Gt. Britain), Tarnishing and Related Phenomena

J. J. Dale (Australia), The Structure of Bright Chromium Electrodeposits

T. Banerjee (India), Experiments on the Electrodeposition of Brass

G. E. Gardam (Gt. Britain), Mechanism of Bright Nickel Plating

In connection with the Conference, a number of *Works' visits* is being planned, of which further details will be available in due course. Members of the Conference may apply for inclusion in any of the parties which will be made up to visit various Works of interest, both in London and the Midlands area.

An *Exhibition* will be on view throughout the Conference at the Hyde Park Hotel illustrating recent developments in electrodeposition research and practice; it is proposed to include a section dealing with wartime applications. Demonstrations of testing equipment, etc., will be carried out on Friday morning, September 19.

All *inquiries and communications* should be addressed to The Conference Secretary, Third International Electrodeposition Conference, Electrodepositers' Technical Society, 27, Islington High Street, N. 1., London, England.

In Remembrance

The month of May witnessed the sad passing of Charles "Charlie" Chace, for many years prominent in the nation's plating councils.

Charlie devoted his whole life to metal finishing. Born in Taunton, Mass., where he attended the public schools, he went to work as a youth at the Cohannet Silver Plant and stayed there about three years. He then went to Poole Silver Company in Taunton and worked with Harry Flanagan whom he succeeded as foreman after several years. Later he operated his own local finishing shop for some time.

In 1924, Gorham Manufacturing Company, Providence, R. I., invited Charlie to work in the plating room as foreman, and he remained in that capacity to the time of his death.

Charlie was the successful President of Providence-Attleboro Branch for ten years when he first came to Providence and had been a conscientious Secretary-Treasurer for the past six years. His personal efforts and delightful personality contributed greatly to the Branch's growth in membership from a faithful dozen in 1927 to a hundred in 1947.

Many times in his early career he was Delegate to National Conventions and always represented the Branch with intelligence and dignity.

Charlie was endowed with a sense of humor that was the joy of all his associates, and he always believed that fun could be had out of the most serious efforts. He was a friend to all, and his contribution to the happiness of others was great.

Locally, we know there will never be another to replace Charlie, and we know that the plating circles in the country will miss that hearty spirit of willing cooperation that typified all the activities of the best friend we in Providence ever had.

May he now enjoy the greatest happiness ever.

William Cahill.

Society Publications in Libraries

According to our latest information, the Society's publications are now available in the following institutions. The ones marked with an asterisk are known to be equipped to supply photostatic copies of any article desired.

Carnegie Library of Pittsburgh, 4400 Forbes Street, Pittsburgh 13, Pa.
THE MONTHLY REVIEW, 1920—complete

Public Library of Cleveland, Cleveland, Ohio
THE MONTHLY REVIEW, 1932—complete

*Library of Congress, Washington, D. C.
THE MONTHLY REVIEW, 1914—complete
Proceedings, 1930–1931, 1933—complete

John Crerar Library, Chicago, Ill.
THE MONTHLY REVIEW, 1914—complete
Proceedings, 1942—complete

*Detroit Public Library, Detroit, Mich.
THE MONTHLY REVIEW, 1936 incomplete; 1937—complete

Grand Rapids Public Library, Grand Rapids, Mich.
THE MONTHLY REVIEW, 1915—complete
Proceedings, 1943—complete

James Jerome Hill Reference Library, St. Paul 2, Minn.
THE MONTHLY REVIEW, 1920—complete

*Los Angeles Public Library, Los Angeles, Calif.
THE MONTHLY REVIEW, 1915—complete
Proceedings, 1927–1928, 1930, 1932–1933, 1935—complete

Milwaukee Public Library, Milwaukee, Wis.
THE MONTHLY REVIEW, 1914—complete

*New York Public Library, 5th Avenue at 42nd Street, New York City
THE MONTHLY REVIEW, Sept. 1933—complete

Ohio State University Library, Columbus 10, Ohio
THE MONTHLY REVIEW, 1920—complete

*The Free Library of Philadelphia, Logan Square, Philadelphia, Pa.
THE MONTHLY REVIEW, 1914—complete
Proceedings, 1914—complete (few pages missing 1921, 1923, 1935)

*The Enoch Pratt Public Library, Baltimore, Md.
THE MONTHLY REVIEW, 1915—complete
Proceedings, 1927, 1929–1933, 1935—complete

Toledo Public Library, Toledo, Ohio
THE MONTHLY REVIEW, 1916–1937 incomplete; 1938—complete

We hereby gratefully acknowledge receipt of back issues of THE MONTHLY REVIEW from the following:

BATTELLE MEMORIAL INSTITUTE, Columbus, Ohio

THE AMERICAN BRASS COMPANY, Waterbury, Conn.

Robt. Steuernagel, Sr.

Robert Steuernagel, Sr., a charter member of the Milwaukee Branch and nationally known for his active interest in A. E. S. affairs, died on April 6.

His personal efforts greatly contributed to the growth and effectiveness of his home Branch. As a member of A. E. S. Executive Board, 1924–1927, he did his part in furthering the broader aims of the Society.

The Milwaukee Branch and his many friends throughout the United States will always remember Bob Steuernagel.

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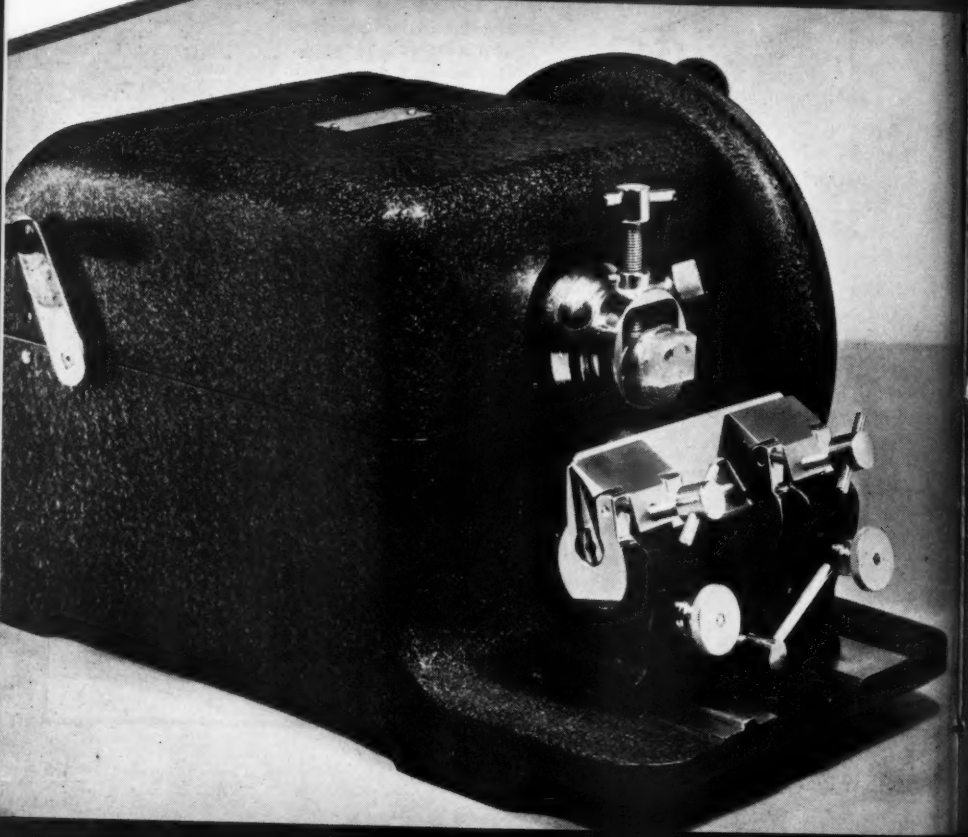

The American Optical Company, manufacturer of SPENCER Scientific Instruments, uses a LEA Method and LEA Compounds for finishing many parts on their well-known No. 820 Microtome. This is a precision instrument widely used in hospital and laboratory work—work that demands the utmost in precision manufacture and finish.

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BOOK REVIEWS

By DR. HAROLD J. READ
Associate Professor of Metallurgy — The Pennsylvania State College

GALVANIZING HANDBOOK by John R. Daesen, 1946, VIII + 166 pages. Reinhold Publishing Corporation, 330 W. Forty-second Street, New York City. Price, $5.25.

The title of this book is quite misleading. There are none of the extensive tables of data, detailed descriptions of plant equipment, etc., which are ordinarily found in a handbook. We find, instead, a rather short monograph on the galvanizing process and the properties of the coatings thus produced.

The author has tried to condense a tremendous amount of information into a very few pages; while in certain respects the result is of considerable interest, the overall effect is disappointing. There has been need for many years of a comprehensive treatise in English comparable with that of Bablik (the English translation of this book is but a sorry travesty on the original); as far as the volume under review is concerned, the need still exists.

The outstanding feature of the book is the excellent collection of photomicrographs and macrographs of the structure of galvanized coatings and the defects which may occur therein. They are well reproduced on good paper and are large enough for easy and significant examination. They occupy nearly 50 pages of the book, and when the pages devoted to other photographs, line drawings, graphs and tables are added, relatively few out of the total 166 remain for textual material.

When the author is describing the practical aspects of galvanizing, he appears to be on solid ground. His definitions of terms and explanations of operations are clear and to the point. In dealing with the theory and principles of the subject, his treatment leaves a great deal to be desired. Possibly the wish to be brief has contributed somewhat to the unsatisfactory discussions, but there is evidence that this is not the only difficulty. Some specific points may be mentioned in this connection.

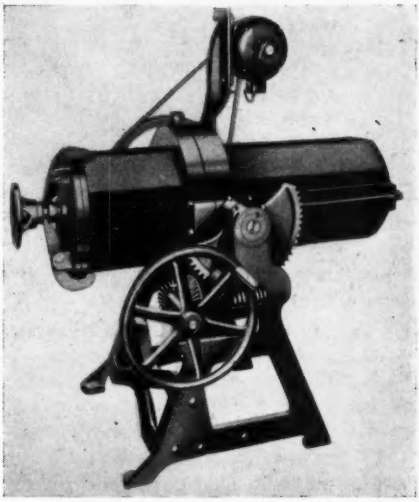
Undue liberties have been taken with the significance of electrode potential listed in the electromotive series. The reader is nowhere warned that variations of the environment may result in another arrangement of the metals.

It is not correct to say that an alloy of the eutectic types freezes "at once" on cooling to the eutectic temperature. If such were the case, the methods of thermal analysis commonly employed in constructing an equilibrium diagram could hardly be used.

The author's explanation of the fact that iron does not accumulate in the flux box is based solely upon the vaporization of "iron chloride", and he quotes the boiling point of ferric chloride as justification. It is not mentioned that there are two chlorides of iron and that the boiling point of ferrous chloride is so high as to preclude its loss by volatilization. The important work of Taussig and others, establishing a probable mechanism by which iron from the flux finds its way into the hard dross, is not mentioned at all.

Because by far the greater part of the book is of a practical nature, these and other objections to the theoretical part may not be too important.

SOMETHING BETTER FOR BURNISHING!



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BRANCH NEWS

BALTIMORE-WASHINGTON BRANCH

The April meeting was held at the Kenesaw Apartments in Washington. A steak dinner preceded the meeting.

ROBERT GUERKE was elected President; CHESTER BETHKE, Vice-President; EDWARD PEEBLES, Librarian; GRACE RIDDELL, Secretar, and RAY STRICKLEN, Treasurer.

Our editor of THE MONTHLY REVIEW, K. G. SODERBERG, of Graham, Crowley and Associates, Jenkintown, Pa., spoke on "Stress in Electrodeposits". He discussed the effects and possible explanations of stress. Basic formulas for determining stress were presented which applied to a new method of making test measurements.

An interesting discussion followed the talk. Twenty-eight were present.

GRACE RIDDELL, *Secretary.*

•

BALTIMORE-WASHINGTON BRANCH

DR. ABNER BRENNER presided over the business meeting and installed the new Officers with Robert Guerke as the new president at the monthly meeting held at the Bureau of Standards on Saturday evening, May 10.

The Branch was fortunate in having A. E. S. PRESIDENT FRANK SAVAGE who spoke to us about the activities of the Society and on new developments in electroforming. Following the talk and discussion, KENNETH M. HUSTON initiated Mr. Savage into the Order of the (Chamber) Pot.

Two motion pictures were shown of wartime activities in the Pacific. Refreshments of ice cream and cake were served. Forty were present.

GRACE RIDDELL, *Secretary.*

BRIDGEPORT BRANCH

The regular monthly meeting was held Friday, April 11 with forty-two members and guests present.

PRESIDENT GOLDMAN reported that the work of the New England Regional Meeting Committee has been concluded. The Bridgeport Branch had sold 120 tickets.

The Branch Research Committee for Sustaining Members reported having signed five Sustaining Members up to the present time: *Casco Products Corporation, E. E. Seeley Company, Schick, Inc., Electrolux Corporation,* and *Remington Rand, Inc.*

The Sick Committee reported that MRS. ABBATTE, wife of JOSEPH ABBATTE, had passed away. The Branch members expressed their sympathy with a floral offering.

The election of Officers gave the following results:

President—FRED B. GOTTHARDT
First Vice-President—CHARLES L. TEMPLE
Second Vice-President—CARL SCHAEFER
Secretary-Treasurer—JOSEPH G. STERLING
Librarian—ANTHONY J. CHENIS
Sergeant-at-Arms—GEORGE J. ECKHOLM
Board of Managers—WILLIAM THOMPSON, WILLIAM FLAHERTY, WILLIAM A. EHRENCRONA, and HUBERT M. GOLDMAN.

CHARLES L. TEMPLE, JOSEPH G. STERLING and V. S. CONSALVO were elected Delegates to the A. E. S. Convention with WILLIAM A. EHRENCRONA, CARL SCHAEFER and ANTHONY J. CHENIS as alternates.

Three members were suspended for nonpayment of dues.

Through the generosity of the Branch members, a sum of $17.00 was realized in a chance program.

JOSEPH G. STERLING,
Secretary-Treasurer.

BRIDGEPORT BRANCH

An Open Meeting and Educational Session was held April 18 at 8:00 P. M., at the Burrough's Public Library Auditorium with sixty-one members and guests present.

Technical Chairman CARL SCHAEFER called upon DR. WALTER R. MEYER of Enthone, Inc., as the speaker of the evening. His subject was "Preparation of Metals for Electroplating". Newer types of cleaning methods for electroplating of copper, brass, ead alloys, tin, zinc base die castings, steel, nd aluminum were presented and illus-arated with slides. The session proved most tnteresting.

JOSEPH G. STERLING,
Secretary-Treasurer.

●

BRIDGEPORT BRANCH

The regular monthly meeting on May 2 was called to order by PAST PRESIDENT H. M. GOLDMAN who officiated at the installation of the new slate of Officers. Forty-five members and guests were present.

PRESIDENT F. B. GOTTHARDT then took the Chair and spoke a few words concerning the progress of the Bridgeport Branch.

Several New York Branch Officers, PRESIDENT GEORGE SCHORE, VICE-PRESIDENT MILTON NADEL and SECRETARY F. J. MACSTOKER were then called upon to present their views on the proposed Constitution. After a thorough discussion by our Branch members, the conclusions were reached that it would (1) take power away from the Branches and limit their activity and (2) cause centralization of the Society's affairs with the Branches having little to say in their direction.

The Delegates were instructed to vote "No" on the suspension of the present Constitution and on the adoption of the proposed new Constitution, and to use their own discretion on other matters.

President Fred B. Gotthardt has appointed the following committees: *Sick Committee:* RAYMOND GORAL, Chairman; E. J. SCULL, HERMAN C. BRAUN, and FLOYD ERLENMEYER. *Membership Committee:* CHARLES L. TEMPLE, Chairman; JOSEPH G. STERLING, ARTHUR R. MCNEIL, and EUGENE PHILLIPS. *Publicity Committee:* EUGENE PHILLIPS, CLARENCE BROWN, and JOSEPH G. STERLING. *Projector Committee:* WILLIAM A. EHRENCRONA and ARTHUR R. MCNEIL. *Meeting Place Committee:* EUGENE PHILLIPS and ARTHUR R. MCNEIL. *Exhibit Committee:* CARL SCHAEFER, Chairman; FRANK J. KALAFUS, and GEORGE WAGSTAFF. *Technical Sessions Committee:* ANTHONY J. CHENIS, Chairman; CARL SCHAEFER, and C. C. HELMLE. *Outing Committee:* EUGENE PHILLIPS, Chairman; WILLIAM A. EHRENCRONA, RAY J. KWASNIK, and ARTHUR R. MCNEIL.

JOSEPH G. STERLING,
Secretary-Treasurer.

●

BRIDGEPORT BRANCH

The Open Meeting and Educational Session on May 16 in the Borough's Public Library Auditorium was opened by PRESIDENT F. B. GOTTHARDT with forty-two members and guests present.

TECHNICAL CHAIRMAN CARL SCHAEFER introduced MR. F. K. SMITH of Technic, Inc., Providence, R. I., who spoke on the Plating of Precious Metals, gold, rhodium, etc., with special attention being given to the development of standardized methods. Procedures and baths for obtaining gold finishes of various colors were described; special attention should be given to the pre-plating operation both when dull and bright finishes are applied. The session proved most interesting, and the group expressed its appreciation to the speaker.

JOSEPH G. STERLING,
Secretary-Treasurer.

●

CHICAGO BRANCH

The regular business of the May meeting consisted of final reports from the retiring Officers, installation of the new Officers, and discussion, article by article, of the proposed new Constitution.

The questions in the question box were answered as follows:

Q. 1. What is the cause of gray streaks in the finished product after a steel article has been nickel plated, nickel buffed, and chromium plated?—A. Poor polishing of the steel, poor buffing of the nickel plate,

or insufficient cleaning of the nickel plate before chromium plating may cause streaking.

Q. 2. Can iron castings be barrel or still plated in a bright zinc bath if first flashed in a cadmium bath?—A. Iron castings can be plated directly with zinc if the following precautions are taken: (a) Thoroughly grit blast the work for cleaning and scale removal; (b) Use high current density by plating a few parts at a time or set the voltage on barrel to a minimum of 15 volts; (c) Use a plating solution with high metal content.

Q. 3. What is the best method of removing scale from heat treated monel bolts?—A. For large production, the sodium hydride method of scale removal is recommended; for small lots, a solution of 15 per cent nitric acid plus 2 per cent hydrofluoric acid at a temperature of 160° F should be employed. Hydrofluoric acid must be used sparingly because of attack on tank linings. Calcium fluoride as a partial substitute for hydrofluoric acid acts as an inhibitor.

Q. 4. What acid dip should be used after cyanide copper striking brass articles prior to bright nickel plating?—A. Five per cent sulphuric acid.

J. H. MONAWECK,
Review Correspondent.

●

COLUMBUS BRANCH

CLOYD A. SNAVELY of Battelle Memorial Institute was elected President at the May meeting held at Hoffman's Gardens.

Other Officers elected at the meeting include J. E. MCCARTHY, *First Vice-President;* A. B. TRIPLER, JR., *Second Vice-President* and *Reporter;* BERNARD AGRUSS, *Secretary-Treasurer,* and W. N. SAFRANEK, *Librarian.* C. L. FAUST, W. NEIL, and E. L. COMBS, Past President, were elected to the Board of Managers.

Messrs. Snavely, Tripler, Agruss, Safranek, Faust and Combs are associated with Battelle Memorial Institute, while Mr. McCarthy is with Wyandotte Chemicals Corporation, and W. Neil is with Columbus Metal Products, Inc.

BERNARD AGRUSS,
Secretary-Treasurer.

DAYTON BRANCH

The regular meeting on May 9 was devoted to the election of new Officers:

President—FRANK J. KLEIN
First Vice-President—RALPH CLINEFELTER
Second Vice-President—HERMAN E. AUSTIN
Secretary-Treasurer—ELMER W. REHME
Librarian—DARWIN H. HUFF
Board of Managers—L. A. CRITCHFIELD, STEPHEN PUTZAN, and FOREST L. VALENTINE.

The new President then took charge of a short business session at which the coming Convention and the proposed changes of the Constitution and By-Laws were discussed.

RALPH CLINEFELTER,
Secretary-Treasurer.

●

DETROIT BRANCH

Ten applicants were elected at the May 2 meeting which will help to make up for the recent loss in membership.

H. HEAD gave a brief progress report on the Industrial Finishing Exposition. BERT LEWIS installed our new Officers, Board of Managers, and Delegates to the Convention.

The motion picture entitled *Flying Fishermen,* shown through the courtesy of Eastern Airlines, was very well received and provided an entertaining break.

The technical portion of the meeting bore the title, "Manufacturers' Night". DR. R. B. SALTONSTALL presided over the presentation of four papers, as follows:

"Problems in Plating Barrel Design" by MR. WILLIAM JACKSON of the Udylite Corporation

"Plating Rack Design" by MR. GEORGE NANKERVIS of the George L. Nankervis Company

"Dividends in Plating Power Supply" by MR. GUY CUMMINGS of Frederick B. Stevens, Incorporated

"Degreasing and Cleaning Equipment" by MR. WILLIAM F. NEWBERY of Detrex Corporation.

All four speakers brought out a number of pertinent points in connection with their particular field, and their talks provoked a variety of good questions which were answered by the respective speakers.

Refreshments were served to the enjoyment of the two hundred in attendance through the courtesy of the above mentioned manufacturers, and the meeting was adjourned until this Fall.

R. H. DUDLEY,
Publicity Chairman.

●

INDIANAPOLIS BRANCH

The regular monthly meeting was held on May 7 at Columbus, Ind. It was "Ladies' Night", and most of the members brought their wives to the dinner. Election of officers was the chief business of the evening, and the following were elected and installed:

President—MARVIN CRAWFORD
First Vice-President—WALTER GULLESON
Second Vice-President—W. W. COTHRAN
Secretary-Treasurer – JAMES MONAGLE
Librarian—DR. A. M. MAX
Board of Governors—CARL NIEHAUS, LOUIS WORRELL, and EDWARD BRUCK
Technical Societies Council Representative—HOWARD PHILLIPS.

One applicant was elected to membership.

Following adjournment, the members and ladies were guests of Noblitt-Sparks Industries, Inc., during a plant visit at the company's "chair" division. Here the group saw a fully conveyorized plating installation in action on high grade tubular furniture. MR. EDWARD REPP, Chief Chemist, described to the group the operation of the equipment.

JAMES MONAGLE,
Secretary-Treasurer.

●

LANCASTER BRANCH

There were twenty-nine members and guests present at the regular meeting on April 11 at the Stevens Trade School.

Two applications for membership were referred to the Board of Managers. The Nominating Committee recommended for *President*, THEODORE SCHWALM; *Vice-President*, CHARLES SNYDER; *Secretary-Treasurer*, H. CLAY BRUBAKER; *Librarian*, CHESTER SMITH; *Board of Managers*, HARRY HOVIS, KARL NUSS, and DAVID FLEMING. The following were appointed Delegates to the Convention: WILLIAM KLUNK and WILLIAM BANNAN with CHARLES SNYDER and FRANK WELLS as alternates.

WILLIAM FORDNEY was appointed Chairman of a committee to study the proposed Constitution and By-Laws and report at our May meeting. ROLAND HOENSTINE was appointed Chairman for the May Stag Party at the Conewago Inn, nine miles north of York, Pa.

LIBRARIAN NORMAN GEBERT introduced our speaker, DR. GARDNER FOULKE, Research Chemist for the Hanson-Van Winkle-Munning Company, Matawan, N. J., who spoke on "Periodic Reverse Plating". The advantages of this method were increased plating rate and metal density, improved surface brightness, heavier deposits, decreased porosity, and better metal distribution.

A discussion period followed.

H. CLAY BRUBAKER,
Secretary.

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LANCASTER BRANCH

The regular monthly meeting on May 9 at the Conewago Inn, nine miles north of York, Pa., was held in conjunction with our annual Stag Party. PRESIDENT HAROLD KILHEFFER opened the meeting with thirty-eight members and guests present. Two new members were received.

WILLIAM FORDNEY, Chairman of the Committee to study the new proposed Constitution, gave his report. After a lengthy discussion, it was decided to instruct the Delegates to use their own discretion.

The following Officers were elected for the coming year:

President—THEODORE R. SCHWALM
Vice-President—CHARLES E. SNYDER
Secretary-Treasurer—H. CLAY BRUBAKER
Librarian—CHESTER W. SMITH
Board of Managers—HARRY HOVIS, KARL NUSS, and DAVID FLEMING.

An hour of fellowship followed with refreshments, movies and cards.

H. CLAY BRUBAKER,
Secretary.

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LOS ANGELES BRANCH

The Los Angeles Branch held its regular

meeting on April 14 at the Elks' Club. Fifty-two persons attended.

Following the dinner, there was a flurry of excitement when MARCUS D. RYNKOFS dropped to the floor and laid unconscious for about five minutes.

LIBRARIAN EXTAKE introduced MR. MORTON SCHWARTZ. His subject, "Plating of Auto Bumper Bars," was based on his experiences in the employ of Standard Steel Spring Company of Coraopolis, Pa. The paper detailed each step from heat treating after forming through polishing to cleaning and plating. The testing of solutions and bumpers was described, and there was some elaboration on the frequency and significance of each test.

Following the formal presentation of his paper, Mr. Schwartz conducted an interesting discussion on cathodic versus anodic cleaning of high carbon steels in 4 oz/gal sodium cyanide solution. Cathodic cleaning of bare high carbon steel in cyanide results in poor adhesion while anodic cleaning gives excellent adhesion of nickel. The reverse holds true for re-runs of rejected nickel plated bars. In order to run rejects in the same cycle, a compromise was adopted consisting of copper striking in the cathodic cyanide cleaner. The copper contributes nothing toward the protective value of the deposit, the protective value being a function of the total thickness of the nickel according to current A. S. T. M. weathering tests. The salt spray test, contrary to the weathering tests, would indicate that the copper enhances the protective value of the coating, but this observation was rejected in favor of the weathering tests which more truly represent actual service conditions of bumper bars.

FIRST VICE-PRESIDENT HOWARD WOODWARD presented the applications of four candidates which were then elected to membership. There were two in-transfers.

The following were elected to office for 1947–1948:

President—HOWARD WOODWARD
First Vice-President—FRANK BUNKER
Second Vice-President—ALLEN SULZINGER
Secretary—DEAN WILLIAMS
Treasurer—GEORGE KENT
Librarian—JOHN D. MILLHORN
Board of Managers—D. N. ELDRED, EARL COFFIN, and E. R. HOLMAN.

It was voted that the Secretary and the Treasurer would each draw a salary of $50 per year.

E. R. HOLMAN,
Secretary-Treasurer.

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LOS ANGELES BRANCH

Approximately 170 members and guests attended the regular meeting on May 12 in the cafeteria of the L. H. Butcher Company when a free dinner and refreshments were served.

EARL COFFIN reported for the New Constitution Committee which recommended against the adoption of the proposed Constitution and that the Constitution Committee be retained to survey the opinions of all the Branches and to prepare a new draft for submission to the 1948 Convention. The Delegates were instructed to vote against the current revision.

Earl Coffin introduced the retiring Officers and instructed and installed the new Officers for the year 1947–1948.

EARL W. ARNOLD of the L. H. Butcher Company, formerly of Cadillac Motor Car Division in Detroit, spoke on the methods used at Cadillac in finishing automobile hardware. He described the use of reverse current in building up the heavy, smooth copper deposits required to meet Cadillac specifications. The copper strike was dumped frequently, often daily, due to heavy production and resulting contamination. The strike was operated at 125° F but without Rochelle salts because no appreciable benefits could be detected.

Nickel was prepared for chromium plating by direct cleaning and a 5 per cent sulfuric acid dip and plated with special electrical equipment which automatically controlled the progressive increase of current. Chromium was thrown into the circular recess on the Cadillac rims by using an intermediate electrode made of $\frac{3}{8}$ inch cold rolled nickel rod; nickel was preferred because lead, being softer, bends more readily and shorts out more frequently.

Although expensive, it was frequently necessary to strip and rework rejected parts

in order to meet assembly line production schedules.

A sound motion picture film, *The Story of Nickel*, provided by the International Nickel Company, was the second educational feature.

There was one in-transfer from the New York Branch.

DON BEDWELL, LEO ATIMION and JACK RASKIN were elected Delegates to the 1947 Convention; ROGER SUNDMARK, TOM TURNER and DICK WOOLEY are their alternates. One hundred dollars was voted to each Delegate to help defray his expenses. Since the majority of the Branches are in the East and Midwest and it would be relatively inconvenient for most of the members to come to Los Angeles and since contributions by Eastern manufacturers, necessary to make the Convention a success, would be quite limited, the Delegates were instructed not to ask for the 1948 Convention but to accept it willingly and gladly if the Society insists on coming.

JOHN HAMOR of Chrome-Nickel Plating Company was reported to be in the Beverly Hospital.

JOHN MERIGOLD proposed that a picnic be held this summer and was appointed Chairman of the Picnic Committee and authorized to select his own committee to investigate and report on suitable times and places.

DEAN D. WILLIAMS, *Secretary*.

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MONTREAL BRANCH

Seventeen members and one guest were present at the May meeting.

RETIRING PRESIDENT ROSS DAVIDSON gave a short talk on the status of the Branch and the Society.

Much time was devoted to the letters from the New York Branch which wished to postpone the revision of the Constitution. It was voted to support the New York Branch as it was felt that more time was needed to allow the Branches to discuss this matter, also that more information should be forthcoming from the Executive Board on the reasons for some of the proposed changes.

MR. J. H. FEELEY thanked the retiring officers and presented the Past President with a pin. The new officers were then installed:

President—F. BOSTON
First Vice-President—E. BOULET
Second Vice-President—J. H. CHARLES
Third Vice-President—E. WALLACE
Librarian—J. FAIRBAIRN
Secretary—WILLIAM GLOVER
Board of Managers—C. DOUGLAS, D. MCMULLEN, and O. MOLDENSCHART.

WILLIAM GLOVER, *Secretary*.

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NEW YORK BRANCH

Friday, May 9, our regular meeting was opened at 8:45 P. M. by President Martin Maher.

Our newly elected Officers for the coming year were installed by the Society's First Vice-President K. M. HUSTON with the able assistance of AL BRAUN of this Branch.

JOSEPH HASS, a member of our Branch, gave a thorough resume of the history of New York Branch entitled "Electroplating, Past, Present and Future." His talk was of interest both to the newer members of our Society and to the older members who reminisced with him.

ALBERT FUSCO,
Recording Secretary.

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NEWARK BRANCH

Not less than nine were elected to membership at the regular meeting on March 21, and there were three applications, one in-transfer, and one out-transfer.

LIBRARIAN ZACHARY IRENAS introduced MR. G. A. LUX of the Oakite Products Company, New York City, whose subject was "Some of the Fundamentals of Alkaline Metal Cleaning". Mr. Lux gave a really fine talk on how to compound a cleaner to help assure that electrodeposits adhere uniformly and demonstrated the effects of wetting or emulsifying agents, water softeners, buffer agents, colloidal substances, and operating temperature. Mr. Lux's presentation was very well received and much discussion followed.

MR. WILLIAM BRUHNS read the changes that the officers thought should be made in the proposed new Constitutions. After a lengthy debate it was decided by the members present to discuss these changes at future meetings.

GEORGE REUTER,
Assistant Secretary.

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NEWARK BRANCH

At the regular meeting on April 18, ACTING LIBRARIAN HOWARD COBB introduced MR. GUSTAF SODERBERG, of Graham, Crowley and Associates, Jenkintown, Pa., and Editor of THE MONTHLY REVIEW, who discussed "Stress in Electrodeposits". Having shown photographs of cracked A. S. T. M. exposure test panels with copper-nickel-chromium coatings, he discussed the stress in nickel coatings as a function of bath composition and how the pre-treatment of buffed copper plate affects cracking and discoloration on outdoor exposure. The talk was most interesting and led to a spirited discussion.

Three applicants were elected to membership, and two new applications were received.

GEORGE REUTER,
Assistant Secretary.

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NEWARK BRANCH

Three applicants were elected to membership and five new applications were received at the regular meeting on May 2.

A communication from New York Branch regarding the new proposed Constitution was read by JOHN DE VRIES and it was decided to discuss this subject at some future meeting.

EDWARD BOWERMAN, Chairman of the Exhibit Committee, expressed the desire that each member would make a sample for the board that Newark Branch hopes to send to Detroit for its Branch Exhibit.

LIBRARIAN ZACHARY IRENAS then introduced the speakers of the evening, both members of the Newark Branch: MR. A. S. KOHLER, whose subject was "Tumble Deburring and Tumble Surface Finishing of Metals and Plastics," and MR. ROBERT HERWIG who gave a demonstration of Water Treatment and Its Application in the Plating Room. Both presentations were very interesting and led to a lively discussion.

GEORGE REUTER,
Assistant Secretary.

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NEWARK BRANCH

Four new members were elected at the regular meeting on May 16. The delinquent members, listed by the Secretary were suspended.

FRANKLYN J. MACSTOKER of New York Branch conducted the election of Officers. The following men were chosen:

President—HOWARD COBB
First Vice-President—WILLIAM HODECKER
Second Vice-President—ROBERT HERWIG
Secretary-Treasurer—GEORGE WAGNER
Librarian—ZACHARY IRENAS
Recording Secretary—SAMUEL FREY
Sergeant-at-Arms—EDWARD BAUERMAN
Board of Managers—HORACE SMITH, LOUIS DONROE, and JOHN DE VRIES.

Delegates to the Convention are HORACE SMITH, GEORGE WAGNER, and ZACHARY IRENAS with SOLOMON E. BARR, SAMUEL FREY, and JOHN GUMM their alternates.

CHARLES A. MARLIES of Metalplast Company was the speaker for the evening and gave an interesting talk on "Metal Coatings on Plastics."

GEORGE REUTER,
Assistant Secretary.

●

PHILADELPHIA BRANCH

FIRST VICE-PRESIDENT RODGERS called the April meeting to order in the absence of PRESIDENT ORLIK. The attendance was thirty-five.

LIBRARIAN HIRSCH presented MR. M. C. WELKER of the American Cyanamid Company who delivered an illustrated lecture on "Demineralized Water in the Plating Room". Particular attention was given to the increasing severity of state laws prohibiting stream pollution by refuse waters from mines and industrial establishments.

The members followed the interesting presentation with many questions, especially about the approximate cost of different types of demineralizing installations.

Two applications for membership were referred to the Board of Managers, and three applicants were elected. There was one outtransfer, and eight members were suspended for non-payment of dues.

DR. A. K. GRAHAM, A. E. S. Executive Secretary, presented his views of the proposed new Constitution. The officers' reports on the same subject started a prolonged discussion during which Messrs. Gehling, Long, Hirsch, Verrelle and others had their say. None had a good word for it. Due to the late hour, it was tabled for further discussion at the May meeting.

The following were nominated and elected without opposition:

President—HENRY G. ORLIK
First Vice-President—THOMAS RODGERS
Second Vice-President—SAMUEL HEIMAN
Treasurer—GEORGE M. LONG
Secretary—PAUL MENTZER, SR.
Librarian—ALBERT HIRSCH
Board of Managers—GEORGE GEHLING, NAT VERRELLE, and E. J. ZURBACH, JR.

HENRY G. ORLIK, PAUL MENTZER, SR., and GEORGE M. LONG were elected Delegates, with ALBERT HIRSCH, I. W. MARCOVITCH, and GEORGE GEHLING as alternates.

PAUL MENTZER, SR.,
Secretary.

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PHILADELPHIA BRANCH

PRESIDENT ORLIK opened the May meeting with about fifty present.

LIBRARIAN HIRSCH introduced MR. W. A. HELBIG, Darco Corporation, whose subject was "Purification of Electroplating Solutions by Filtration and Activated Carbon Treatment".

The speaker began by outlining the history of the use of activated carbon which began with sugar refining and spread to treatment of edible oils, water, chemicals, pharmaceuticals, dry cleaners' solvent, and finally to plating solutions. Assisted by MR. J. C. SHARBAUGH who had brought a Sparkler filter, he decolorized a solution. Mr. Helbig was interrupted from time to time with questions which he ably answered.

Two applications were referred to the Board of Managers, and two approved applicants were elected to membership. One member was suspended for failure to send forwarding address.

The secretary read the report of the Branch Research Fund Committee, AL HIRSCH, Chairman, which showed that the Branch has eight sustaining members to its credit.

All meetings will be suspended for the summer months; the next meeting will be held on the fourth Friday of September.

PAUL MENTZER, SR., *Secretary.*

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PITTSBURGH BRANCH

In the absence of R. A. DIMON, R. J. GOLDBACH acted as secretary during the regular meeting on March 20.

MR. WALTER PINNER, Past A. E. S. President, discussed the proposed Constitution and urged its acceptance by this Branch. PRESIDENT KELLER appointed a committee consisting of DR. LANCY, S. S. JOHNSTON, and R. A. DIMON to represent the Branch and rally supporting for the new Constitution.

Election of officers for the year beginning May 1, 1947, was held with the following results:

President—W. J. HENNESSY
First Vice-President—G. A. JERSEY
Second Vice-President—JOHN P. COROS
Librarian—REGIS J. GOLDBACH
Secretary-Treasurer—R. A. DIMON
Board of Managers—S. S. JOHNSTON, LEO SCHMITT, and FRANK KELLER.

Delegates to the Convention are S. S. JOHNSTON, W. J. HENNESSY, and F. R. KELLER, with LEO SCHMITT, R. J. GOLDBACH, and R. A. DIMON as alternates.

LIBRARIAN HENNESSY then introduced MR. WALTER PINNER who gave a very interesting and well received talk on the subject of "High Speed Nickel Plating".

RICHARD A. DIMON, *Secretary.*

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PITTSBURGH BRANCH

In place of the regular meeting, the Branch held its annual "Ladies' Night" at the Colonial Inn on Wednesday evening, April 16. Approximately ninety members and guests enjoyed an excellent turkey dinner which had been arranged by the

committee consisting of R. J. Goldbach, Chairman, and W. B. Williams, William Hennessy, J. P. Coros, M. C. Griffith, Robert E. Geuder, and Myron Ceresa.

Mr. Williams proved a very capable Master of Ceremonies, introducing the entertainment and awarding door prizes to the ladies holding lucky numbers. The evening was concluded by dancing. All agreed that it was one of the most successful parties the Branch has given.

R. A. Dimon,
Secretary-Treasurer.

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PITTSBURGH BRANCH

The final meeting of the year was held at the Bureau of Mines Auditorium on May 16. The retiring President Frank Keller, opened the meeting, and after the reading of the Treasurer's Annual Report, turned the meeting over to the incoming President, W. J. Hennessy. Mr. Keller was given a rising vote of thanks for his able direction of the Branch during the past year.

Nine new members were elected to the Branch.

S. S. Johnston reported for the Committee on the New Constitution of which Dr. Lancy is Chairman. The consensus of the committee was that published version lessens the autonomy of the Branches to an undesirable degree. All other members of the Branch who commented on this matter were unanimous in their opinion that the interest in Branch activities which has greatly increased in the last few years has resulted largely from the independence of the Branches of this Society as opposed to the relative unimportance of branches in other technical societies.

President Hennessy announced the following committees:

Entertainment Committee: G. A. Jersey, R. J. Goldbach, Arthur Mock, Richard Smith, and Joe Wray; *Librarian's Committee:* R. V. VandenBerg, Myron Ceresa, E. J. Smith, Mathew Drozd, and Glade Bowman; *Committee To Investigate Summer Outing:* A. F. Kaupe, E. J. Smith, W. B. Williams, and Fred Dixon.

The meeting was then turned over to Mr. Ralph Pettit of the Aluminum Company of America who discussed "Electroplating on Aluminum". Mr. Pettit, who is a member of our Branch, gave an excellent resume of the historical background of plating of aluminum, referring finally to recently developed processes such as the "Krome-Alume" and zinc-immersion methods for securing excellent adhesion of plated coatings. He displayed a number of samples prepared by means of these processes and concluded with an interesting talking-movie entitled *Date-line Tomorrow* which the Aluminum Company has produced to give a complete picture of the part that various aluminum finishes will play in tomorrow's applications of this very important metal.

After a discussion period during which the speaker answered a large number of questions, the meeting was adjourned.

Richard A. Dimon,
Secretary-Treasurer.

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ROCHESTER BRANCH

One applicant was elected to membership and one new application was received at the monthly meeting on April 18.

A committee consisting of Joe Hull, Don Blum and Paul Tufts was appointed to report on the proposed new Constitution at the next meeting.

The Rochester Branch has been honored through the appointment of Mr. William Tucker as Vice-Chairman of the Research Directing Sub-Committee of the A. E. S. Research Committee. Mr. Tucker outlined the aims and purposes of the research program.

Dr. Ralph L. Van Peursem, Supervisor of the Chemistry Department at the Rochester Institute of Technology, outlined a program of instruction in Metal Finishing which the Institute has inaugurated. It will consist of two parts: a cooperative training course described in the February issue of The Monthly Review and a technical service and research program. It is believed to be the first cooperative training course in electroplating and metal finishing in this country.

Robert L. Flint, *Secretary.*

ROCKFORD BRANCH

Three papers were presented at the Annual Educational Session and Banquet on March 29: "Copper Plating with Fluoborates" by MR. A. E. CARLSON of the General Chemical Company, "The Chemistry of Wetting Agents" by DR. DONALD PRICE of the Oakite Company, and "Metal Polishing with Abrasive Belts" by MR. O. B. GORDON of the Behr-Manning Corporation.

The Banquet held the same evening was attended by about two hundred couples.

Plans are being made for the Annual Stag Picnic to be held this year on Saturday, August 9. The place as yet has not been set, but the usual good time is assured.

VERN T. WISSEN, *Secretary.*

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ROCKFORD BRANCH

The speaker at the June meeting was DR. EDWARD A. PARKER of Technic, Inc., Providence, R. I. This was another in a series of fine programs that the Branch has been enjoying during the year.

The proposed new Constitution was discussed and the Delegates instructed as to the wishes of the Branch.

Plans for the annual Stag Picnic were also discussed and the date set for August 23. WILLIAM FOLEY is in charge of location, WALTER MACKAY is Chairman of the Entertainment Committee, and LEROY JOHNSON is responsible for refreshments. Tickets may be obtained through the BRANCH SECRETARY VERN WISSEN, Spring Creek Road, Rockford, Ill.

The usual summer vacation begins after the June meeting, and the next regular meeting will be held the second Monday of September at the Faust Hotel.

VERN WISSEN, *Secretary.*

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SAN FRANCISCO BRANCH

Twenty-one members and five guests attended the monthly meeting in the El Curtola Restaurant in Oakland on April 17.

Action will be taken at the May meeting on voting funds for the expenses of a Delegate or Delegates to the Convention.

H. MORGAN, F. CAVALLERA and J. ULRICH were appointed to serve on the Nominating Committee.

Six new members were received into the organization.

MR. RICHARD B. LORD of the General Electric Company spoke about "Rectifiers". His presentation covered planning of rectifier installations, their construction, operation, and maintenance.

FRED W. HUNTINGTON,
Secretary-Treasurer.

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SAN FRANCISCO BRANCH

Twenty-one members and two guests attended the regular monthly meeting on May 15.

J. R. PATTENGER was elected Delegate to the Convention, and $150.00 was voted toward defraying his expenses.

STANLEY COLE, Chairman of the Membership Committee, reported that it is concentrating on the local firms with plating operations that are not yet represented in our organization.

Three applications for membership were presented and approved.

A most interesting talk was delivered by MR. LYNDS JONES, Superintendent of Schlage Lock Company, on his recent trip through the Midwest where he visited many of the large industrial plating plants. Mr. Jones spoke about new developments and methods in the industry that he had noted. He also explained the organization, purposes and operation of the Battelle Development Corporation and the Battelle Memorial Institute in Columbus, Ohio.

Election of Officers for the 1947–1948 year was held with the following results:

President—FRED W. HUNTINGTON
Vice-President—J. R. PATTENGER
Secretary-Treasurer—JACK HITE
Librarian—FRANK CAVALLERA
Board of Managers—L. DELAMOTHE, E. M. ALEXANDER, and FRED P. DARTT.

FRED W. HUNTINGTON,
Secretary-Treasurer.

SPRINGFIELD BRANCH

The April meeting was held on April 28. NORMAN PLANK, JOHN HORRIGAN, and LAURENCE FOUNTAIN were appointed Delegates to the Convention, with JOHN COSTIGAN, ERNEST COUTURE and CARLOS BUTLER to serve as their alternates.

It was voted that the new Constitution be tabled for one year so it can be properly studied.

One new member was elected, and two old members were reinstated.

The Chairman of the Library Committee, Mr. Horrigan, then introduced the speakers. MR. ARTHUR ZAVARELLA gave a short talk on "Duplex Chrome Plating" and also showed several samples of this type of plate.

MR. ARTHUR LOGOZZO, A. E. S. Third Vice-President, gave a very interesting talk on "Decorative and Hard Chrome Plating" and also discussed barrel chromium plating.

A fine collection of slides helped put across his talk. In fact, it was such a good demonstration that very few questions remained to be asked during the question period.

LAURENCE R. FOUNTAIN,
Secretary-Treasurer.

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SPRINGFIELD BRANCH

Three men were elected to membership at the May meeting on May 26.

The installation of Officers took place at this meeting as follows:

President—ERNEST COUTURE
First Vice-President—JOHN COSTIGAN
Second Vice-President—ARTHUR ZAVARELLA
Secretary-Treasurer—LAURENCE FOUNTAIN
Board of Managers—FRANK SCHULTZ, FRANCIS O'DONNELL, and ARTHUR COPP
Library Committee—JOHN HORRIGAN and NORMAN PLANK.

John Horrigan, Chairman of the Library Committee, then introduced DR. W. R. MEYER of the Enthone Company, New Haven, Conn., who discussed in a very interesting manner what makes a good alkaline cleaner, and the plating on lead, zinc, and aluminum.

LAURENCE R. FOUNTAIN,
Secretary-Treasurer.

SOUTHEASTERN BRANCH

The regular meeting was held on April 10 at the Robert Fulton Hotel with eighteen members present.

After a very nice supper, CARL CARTLEGE, FRED FLETCHER and D. J. GRIFFIN were appointed to serve on our Sick Committee. It was agreed that a flower offering, not to cost more than $7.50, will be sent in case of death of a member or in a member's immediate family.

The present officers were re-elected for another term except that Carl Cartlege will take the place of DURWOOD SMITH as Second Vice-President, Mr. Smith having left the city.

Our speaker of the evening was MR. WILLIAM GUANT of United Chromium, Inc., who gave a very interesting talk on racking that was enjoyed by all. Mr. Guant also answered many questions pertaining to plating.

WILLIAM T. WEYMOUTH,
Secretary-Treasurer.

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SOUTHEASTERN BRANCH

Our regular monthly meeting was held in Birmingham on May 16 with sixteen members present.

The election of Delegates to the National Convention at Detroit gave the following result:

Delegates: R. E. NORMAN, B. DEUTSCHMAN, and WILLIAM T. WEYMOUTH. *Alternates:* D. J. GRIFFIN, H. WEBB MITCHELL, and H. R. STOGNER.

After a thorough discussion of the proposed new Constitution, it was decided to endorse the petition filed with the Executive Secretary for a year's postponement.

WILLIAM T. WEYMOUTH,
Secretary-Treasurer.

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SYDNEY BRANCH

Twenty-nine members and visitors attended the regular monthly meeting on April 18.

It was decided to hold a dinner on the night of the June meeting. The Educational Committee was endeavoring to acquire

some films on the processing of nickel to be shown on that night.

When PRESIDENT E. J. WRIGHT announced that one of the Branch members, D. E. WILLOUGHBY, had been accidentally killed the previous week, the members stood in silence for two minutes.

The membership committee reported good progress with five candidates awaiting election at the June meeting.

The speaker for the evening was MR. FRED STEVENS who gave a resume on The Use of Polyvinyl Chloride Plastics in the Plating Industry. The topic proved interesting to all present and was followed by discussion of the merits and demerits of the plastic applied to racks, tanks, etc.

J. R. GODFREY, *Secretary.*

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SYRACUSE BRANCH

The May 16 meeting was held as usual in Bowne Hall, Syracuse University.

The report of the Nominating Committee (T. DUVALL, H. GERHARDT, W. LANGENMAYR, and L. WOOD) was received, and additional nominations were made from the floor. Ballots containing the following names will be mailed to all members:

For *President*—GEORGE SIMMONS and N. MAFFEI; for *First Vice-President*—P. SCHWARTZ, N. MURPHY and L. WOOD; for *Second Vice-President*—H. GERHARDT and G. CAVANAUGH; for *Secretary-Treasurer*—M. BOLAND and V. MCCONNELL; for *Librarian*—GEORGE LAWRENCE and GEORGE SIMMONS; for *Board of Managers*—G. ANDREWS, N. HOLBERT, F. HOPKINS, A. MARTINEAU, W. PHILLIPS, and BEN RENSIN.

Delegates to the Convention are GEORGE SIMMONS, M. BOLAND, and H. HOLBERT with GEORGE CAVANAUGH, I. HOOD, and H. GERHARDT as alternates. Following considerable discussion of the proposed new Constitution, the Delegates were instructed to follow the suggestion of the New York Branch that consideration be postponed for one year.

The Chairman of the Branch Research Committee, M. BOLAND, gave a report and submitted a letter which had been sent to various industrial firms in the vicinity. Several replies have been received.

N. F. MURPHY, *Secretary.*

TOLEDO BRANCH

Fifteen members attended the Annual Meeting on April 3.

MR. SPANOLIS was elected to Honorary Membership of the Toledo Branch by unanimous vote.

Two applications were accepted. The Chair appointed JOHN BANTA, CHARLES VANNORSDALL and DONALD ZUCK to the Nominating Committee and JOHN STEGEMAN, JOHN WEIGHT, and WALTER WEIKER to the Auditing Committee.

Following the Nominating Committee's report and nominations from the floor, the following Officers were elected:

President—JOHN BANTA
First Vice-President—JOHN STEGEMAN
Second Vice-President—JAMES GERITY
Secretary—G. BERGEMAN
Treasurer—EDWARD ST. ARNAUD
Librarian—GLENN NOE
Board of Managers—CLEON TRIPLETT, WALTER WEIKER, and CHARLES VANNORSDALL.

Delegates to the Convention are G. BERGEMAN, CHARLES VANNORSDALL and WALTER WEIKER with JOHN STEGEMAN, DONALD ZUCK, and CLIFFORD COLE as alternates.

G. BERGEMAN, *Secretary.*

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TORONTO BRANCH

In the absence of PRESIDENT BLANDY, VICE-PRESIDENT BILL PRICE took the chair at the March 14 meeting.

The excellent meal was accompanied by a beverage through the courtesy of MR. FRANK GRIGGS of Canadian Hanson and Van Winkle Company. This month there were two prizes for the lucky draw. The first prize, a product of Seagram's donated by FRANK OAKLEY, was won by ARCHIE CUTLER. The second prize, donated by MR. SAUNDERS of Hiram Walker, Ltd., was won by BENNY CAMERON.

An extra lively business session followed. There was one application for membership, and election of six new members. Considerable discussion followed the report of the Executive Committee. The Nominating Committee's slate of nominees for the 1947–1948 Executive Board was presented by JOE FITZSIMMONS and approved after a lively debate. John Acheson, Chairman of

the Euchre Committee, gave an excellent report on the Euchre Party to be held on March 26.

Joe Fitzsimmons, Chairman of the Bowling Committee, reported that the Spring Bowling Night would be held on the last Friday in April.

Mr. John Acheson then presented a paper on Plating—Past and Present. A Charter Member of the Branch and a Past President, with continuous experience dating back to the early days of nickel plating, Mr. Acheson has just what it takes to make the history of plating both authoritative and extremely interesting. With numerous samples of articles which were plated by various methods, he ably described the early amalgam process of the Egyptians, close plating, Sheffield plate, and the development of the electroplating industry up to the present day. All the early electroplating was done with the aid of primary cells. The development of platers' equipment, from the first generators and rheostats to those employed today, was given in a very interesting fashion. Comparison of the methods and solutions used when Mr. Acheson first started plating with present-day practice was most enlightening as an excellent indication of the rapid progress that can be expected in the future. At the conclusion of his formal presentation, Mr. Acheson answered many questions and was given a hearty applause by the forty-seven members and guests who attended.

The Question Box centered around the Los Angeles Plating Plant explosion and the dangers of perchloric acid and led to a general discussion on the merits of different solutions used for electropolishing.

J. L. Vaughan,
Review Correspondent.

●

TWIN CITY BRANCH

There were fifty persons present at the April 7 meeting. One new member was welcomed.

President Lillicrop named the following members to the Auditing Committee: N. A. Glenn, Chairman; Frank Nelson, and E. W. Presser.

Branch Librarian Dr. Frank Ireland introduced Mr. Ralph Pettit of the Aluminum Company of America who spoke on "Finishes for Aluminum" and showed movies on this subject. The talk was very interesting and informative.

Robert L. Buckley,
Secretary-Treasurer.

●

TWIN CITY BRANCH

The Twin City Branch met on May 5 with forty-seven persons present.

A. T. Leonard, Membership Chairman, introduced one new member.

The Secretary reminded those present of the coming Convention. A list of members with perfect attendance was read in preparation for a drawing for a worth-while prize to be conducted at the June Party.

The new Officers for the 1947–1948 fiscal year are:

President—A. T. Leonard
First Vice-President—R. M. Krieger
Second Vice-President—Frank Ireland
Secretary-Treasurer—Robert L. Buckley.

G. W. Lillicrop, the retiring President, was presented with the Past President's gavel by the new President.

A report on the coming Third Annual Party was given by John Lynard, Chairman. It will be held on Thursday, June 5, at the Covered Wagon, Minneapolis, Minn.

Following the business meeting, Dr. Frank Ireland, Branch Librarian, introduced Dr. H. L. Kellner, Technical Director of Lea Manufacturing Company, who spoke on "Polishing and Buffing of Metals". Movies were shown in addition to a demonstration of spray-buffing. Dr. Kellner's talk was most interesting and much appreciated.

Robert L. Buckley,
Secretary-Treasurer.

●

WATERBURY BRANCH

The Officers' annual reports presented at the May 9 meeting showed that the Branch had made progress during the year: the membership had increased, and attendance at the monthly meetings has been very good. This demonstrated that the efforts

of our Librarian to provide an interesting program has been successful.

The special Educational Course started off well, and the attendance was good. Much of value was obtained from the exchange of ideas and the discussions which formed a prominent part of each meeting. The small attendance at business meetings, however, has been a matter of concern to our President, BERT SAGE. He expressed the hope that during the coming year more of the membership would attend these important meetings where the business of the Branch is transacted.

ELLSWORTH CANDEE reported on a meeting that he, EARL COUCH and TONY MAZ had had with a representative of the Mt. Washington Hotel. This hotel, situated in the most scenic part of the White Mountains, with elaborate facilities for housing and entertaining guests, can adequately take care of a National Convention. This possibility was discussed, and the Branch felt that with such a place available, we could successfully sponsor a Convention. Therefore, it was voted that we ask the coming Convention for permission to hold the 1948 National Convention at Bretton Woods.

Each proposed change in the Constitution was next discussed in detail, under the leadership of Ellsworth Candee. The opinion of the members was noted for the guidance of our Delegates at the National Convention.

The following were unanimously elected to serve as Officers for the coming year:

President—HENRY STROW
First Vice-President—WILLIAM STARR
Second Vice-President—GEORGE HISERT
Secretary-Treasurer—SPENCER HENN
Assistant Secretary—ARTHUR TRACY
Librarian—EARL COUCH
Assistant Librarian—ELLSWORTH CANDEE
Board of Managers—ANTHONY MAZ, W. L. CASSELL, and BERT SAGE.

The following were elected Delegates to the Convention: BERT SAGE, LOUIS LOUGEE, and ELLSWORTH CANDEE; alternates are JOSEPH MCCONAS, HENRY STROW, and PERRY SLOANE.

DR. LOUIS WEISBERG, the speaker of the evening, chose for his subject, "The Effect of Organic and Colloidal Materials on Properties of Electrodeposits". Illustrating his talk largely from experiences in bright nickel plating, Dr. Weisberg showed that many substances have a profound effect upon the structure of the deposit; many materials have remarkable brightening effects in minute quantities, but due to undesirable qualities relatively few substances are desirable for this purpose. The mechanism of brightening, interference with crystal growth, is practically the same in all cases.

Dr. Weisberg's talk was informative and much appreciated by the Branch, as have been his other talks in the past.

S. L. HENN, *Secretary.*

✝

Don C. Gardner

Don C. Gardner, well-known publisher of "Products Finishing" and other trade journals both in United States and abroad, died on May 16. He had been suffering from a nerve ailment.

Mr. Gardner, born in Monticello, Ind., in 1889, spent his life in the publishing business, first newspaper and later in the magazine field. With Howard Campbell he formed the Gardner Publications, Inc., in 1928 and remained its president till his death.

A civic leader in his home town of Cincinnati, Ohio, he belonged to many local and National organizations.

May he rest in peace.

Outstanding!
McGEAN
BRIGHT NICKEL
PLATING PROCESS
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Chairman, Membership Committee

ELECTIONS

BALTIMORE-WASHINGTON BRANCH

Fielding Ogburn, 2615 Fourth St., N. E., Washington 2, D. C.

William C. Schaefer, Sr., 2601 Hillcrest Ave., Parkville 14, Md.

BOSTON BRANCH

Hervey E. Cote, 134 Canterbury Street, Worcester, Mass.

BRIDGEPORT BRANCH

Philo Bailin, c/o Columbia Recording Corporation, 1473 Barnum Ave., Bridgeport 8, Conn.

Wilson Crawford, Jr., c/o Superior Plating Company, 112 Admiral St., Bridgeport 5, Conn.

Alphonse J. Czarnecke, 66 N. Washington Ave., Bridgeport 4, Conn.

Joseph B. Filardo, 36 Stephen St., Stamford, Conn.

Anthony J. Gasparino, 9 Harold Ave., Greenwich, Conn.

Alfred K. Hanson, 516 Laurel Ave., Bridgeport 6, Conn.

William H. Holbeck, c/o Electrolux Corporation, Forest Ave., Old Greenwich, Conn.

Charles Pataky, 523 Black Rock Turnpike, Bridgeport 5, Conn.

Ernest Reichenberg, 40-67 Hampton St., Elmhurst, L. I., N. Y.

Daniel Romano, c/o Stamford Polishing Company, Stamford, Conn.

BUFFALO BRANCH

John S. Labuda, 24 Glor St., Buffalo 7, N. Y.

Raymond Lawicki, 353 Sherman St., Buffalo 12, N. Y.

William Lawicki, 171 Esser Ave., Buffalo, 7, N. Y.

Louis Sones, 1 Peoria St., Buffalo 7, N. Y.

CHICAGO BRANCH

W. G. Bott, Jr., 1308 Watline St., Arlington Heights, Ill.

Henry Cannon, 1739 N. Wolcott Ave., Chicago 40, Ill.

E. Elies, 3635 N. Mozart St., Chicago 18, Ill.

F. Erskine, 832 Gunnison St., Chicago 40, Ill.

R. Gawron, 4243 W. Walton St., Chicago 51, Ill.

G. Grow, 805 Buckingham Place, Chicago 13, Ill.

R. M. Guetzow, 650 S. 25th Ave., Bellwood, Ill.

H. Kob, 1349 Webster Ave., Chicago 14, Ill.

J. Madden, 1146 Madison St., Oak Park, Ill.

J. V. Matthews, 214½ N. Fourth St., Burlington, Iowa

S. Mogavero, 1146 Madison St., Oak Park, Ill.

J. Pokorny, 314½ N. Menard Ave., Chicago 44, Ill.

G. Reinhardt, 1431 Lake Ave., Wilmette, Ill.

J. Schneider, 2447 W. Cuyler Ave., Chicago 18, Ill.

R. Steel, 5431 W. Hirsch St., Chicago 51, Ill.

Ralph J. Urban, 908 W. Erie St., Chicago 22, Ill.

W. Westfall, 4600 Belle Plaine Ave., Chicago 41, Ill.

P. Zogg, 6602 Wentworth Ave., Chicago 21, Ill.

CINCINNATI BRANCH

Charles H. Crutcher, 302 E. 33rd St., Covington, Ky.

John Kuhl, 2214 Langdon Farm Rd., Cincinnati 12, Ohio

Harold J. Palmer, 3529 Meadow Ave., Cheviot, Ohio

Charles W. Parks, Harshaw Chemical Co., 611 American Bldg., Cincinnati 2, Ohio

CLEVELAND BRANCH

Thomas J. Navin, 6609 Detroit Ave., Cleveland 2, Ohio

Frederick F. Sauer, 4218 Mapledale Ave., Cleveland 9, Ohio

Norman E. Sheridan, Wagner Rustproofing Co., 7708 Quincy Ave., Cleveland 4, Ohio

William A. Walton, 1341 W. 76th St., Cleveland 2, Ohio

Dale E. Williams, General Fireproofing Co., Youngstown, Ohio

COLUMBUS BRANCH

Edwin J. Geldien, 10 E. Hudson St., Columbus 2, Ohio

Lawrence A. Maloy, 40 Bron-Shoe Co., 269 E. Broad St., Columbus, Ohio

DAYTON BRANCH

Robert S. Redman, 202 Rubican St., Apt. No. 5, Dayton 9, Ohio

DETROIT BRANCH

A. A. Adams, 4752 Ternes, Dearborn, Mich.

Margaret L. Baty, Box 113, Redford Star, Detroit 19, Mich.

B. A. Briton, 1165 Beaufait St., Detroit 7, Mich.

Guy A. Cummings, F. B. Stevens Inc., 510 Third St., Detroit, Mich.

Leslie Deans, 60 Highland, Apt. 208, Highland Park 3, Mich.

Thomas J. Doyle, Plating Department, Pontiac Motors Div., Pontiac, Mich.

D. L. Hancotte, Jr., 2563 Sharon Ave., Detroit 9, Mich.

John S. Hart, 4019 Beaufait, Detroit 7, Mich.

Frank Howze, 1510 W. Lafayette, Detroit 16, Mich.

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Matthew Lang, F. B. Stevens Inc., 510 Third St., Detroit, Mich.

Thomas W. Le Pine, 1510 W. Lafayette, Detroit 16, Mich.

T. C. Mahoney, 994 Madison, Detroit 7, Mich.

P. W. McKenney, Dunston Rd., Bloomfield Hills, Mich.

J. A. Mullen, 1165 Beaufait St., Detroit 7, Mich.

J. P. Nielsen, Spring Lake, Mich.

J. G. Ottati, 6121 Yorkshire, Detroit 24, Mich.

William C. Pollard, 145 Beresford, Highland Park 3, Mich.

E. H. Smith, 6025 Rosemont, Detroit 10, Mich.

D. Belding Stow, 2970 Taylor, Detroit 6, Mich.

W. J. Tafel, 1986 Scotten Ave., Detroit 9, Mich.

James Thomas, 15734 Cruse, Detroit 27, Mich.

Lee D. Walters, 626 Fisher Building, Detroit 2, Mich.

HARTFORD BRANCH

Julie P. Majkowski, Conn. Telephone & Elec. Div., Britannia St., Meriden, Conn.

INDIANAPOLIS BRANCH

Herbert E. Adams, 917 Massachusetts Ave., Indianapolis 4, Ind.

Thomas H. Adams, 917 Massachusetts Ave., Indianapolis 4, Ind.

Nello R. Arterburn, 2123 Keller Ave., Columbus, Ind.

Merrell Beyer, 3305 E. Michigan St., Indianapolis 1, Ind.

Harold A. Chamness, 27 N. Tremont, Indianapolis, Ind.

Robert B. Ellsworth, 264 W. 54th St., Indianapolis, Ind.

Lowell S. Fisher, 31 E. 45th St., Indianapolis, Ind.
Carroll P. Hinchman, 250 N. Beville Ave., Indianapolis, Ind.
Max Malvase, 330 W. New York Ave., Indianapolis, Ind.
Robert C. McColgin, 342½ E. 10th St., Indianapolis, Ind.
Earl D. Moore, 448 W. 31st St., Indianapolis, Ind.
Oscar A. Moore, 1106 Southeastern Ave., Indianapolis 2, Ind.
Howard D. Phillips, 1026 Shelby St., Indianapolis, Ind.
M. Lester Reynolds, 328 E. 47th St., Indianapolis, Ind.
Roland T. Watson, Colors Inc., 2231 N. Sherman St., Indianapolis, Ind.

LANCASTER BRANCH
Richard L. Knerr, 1835 Briggs St., Harrisburg, Pa.
LeRoy H. Hain, 643 Juliette Ave., Lancaster, Pa.

LOS ANGELES BRANCH
Thomas A. Foster, Latex Dipped Products Co., 4620 E. Washington Blvd., Los Angeles 22, Calif.
M. Goldman, 657 E. 61st St., Los Angeles 1, Calif.
John R. Mergell, 4620 E. Washington Blvd., Los Angeles 22, Calif.
Louis G. Shoals, 657 E. 61st St., Los Angeles 1, Calif.

MILWAUKEE BRANCH
Gordon J. Einberger, 910 S. 23rd St., Milwaukee 4, Wis.
L. J. Moyes, 1137 N. Van Buren St., Milwaukee, Wis.
Walter W. Vogue, Hamilton Beach Co., Rapids Drive, Racine, Wis.

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Gerald G. Ascione, Industrial Plating Co., 772 Comminipaw Ave., Jersey City, N. J.
Alphonse Cappetta, 89 Walnut St., Bloomfield, N. J.
Allan A. Cole, 475 Fairview Ave., Orange, N. J.
Kenneth Curry, 146 Delevan Ave., Belleville, N. J.
John M. Davidson, 2307 Hill Road, Westfield, N. J.
Michael W. Frazzano, 65 Park Ave., Bloomfield, N. J.
Robert I. Horrocks, 79 Highfield Lane, Nutley 10, N. J.
Frank X. Hulser, Jr., 4410 25th Ave., Astoria, L. I., N. Y.
Max Idel, 168 Coit St., Irvington, N. J.
Herbert E. Jennings, 671 Lincoln Ave., Orange, N. J.
Michael J. Mallardi, 1623 Library Ave., Bronx, N. Y.
Robert E. Moore, 51 Forest Hill Rd., West Orange, N. J.
Henry J. Nash, 60 Midland Ave., Glen Ridge, N. J.
Peter Pawlyk, 42 Cathedral Ave., Nutley 10, N. J.
Joseph Ringers, 251 N. 8th St., Paterson, N. J.
Fred Rosamilia, 205 Highland Ave., Newark, N. J.
Theodore Whitlock, Jr., 19 Water St., New Brunswick, N. J.

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Alvin I. Englander, 3951 Grosvenor Ave., Bronx 63, N. Y.
Irwin Goldman, 131-08 226th St., Laurelton, N. Y.
James M. Joyce, Jr., Sperry Gyroscope Co., Great Neck, N. Y.
Herbert S. Landau, United Fireplace Equipment Mfgs. Ltd., Suffern, N. Y.
Benjamin Lapidus, 1045 Atlantic Ave., Brooklyn 16, N. Y.
Samuel Levine, 17 E. 88th St., Brooklyn 12, N. Y.
Donald B. Lytle, 270 Bronxville Rd., Bronxville, N. Y.
Eugene A. McCarthy, 151 E. 4th St., Brooklyn 18, N. Y.
Bernard P. Planner, 112-15 72nd Rd., Forest Hills, N. Y.
Martin H. Pollack, 130 Elliott Place, Bronx 52, N. Y.
Donald Price, 166 E. 96th St., New York 28, N. Y.

Max Randall, 410 E. 93rd St., New York 28, N. Y.

Burt I. Sherman, 650 Bedford Ave., Brooklyn 11, N. Y.

Albert O. Siever, c/o Dowd, 3095 34th St., Astoria, N. Y.

Joseph F. Wolf, Yorkville Plating Co., 508 E. 74th St., New York 21, N. Y.

PHILADELPHIA BRANCH

A. K. Chatterjee, Snell & Priteaux Ltd., Exeter Passage, Birmingham 1, England

John J. De Pasquale, 7510 Rugby St., Philadelphia 19, Pa.

A. Goldstein, Dascher Mfg. Co., 3201 Arch St., Philadelphia 4, Pa.

David Halpert, 7327 Limekiln Pike, Philadelphia 38, Pa.

Frank P. Smith, 1810 Wishart St., Philadelphia 34, Pa.

PITTSBURGH BRANCH

K. G. Bentzen, 1 Harvard Drive, Pittsburgh 21, Pa.

Rolland E. Campbell, G. G. Greene Mfg. Co., Warren, Pa.

Joseph Caro, 480 Cypress Dr. (Mooncrest), Coraopolis, Pa.

S. T. Cheng, 1019 Coal St., Pittsburgh 21, Pa.

Fred M. Dixon, 330 Hill St., Sewickley, Pa.

Edmond C. Dorsky, 1317 Woodward Ave., McKees Rocks, Pa.

Stewart H. Jones, 342 Park Ave., Johnstown, Pa.

J. G. Limon, P. O. Box 867, East Pittsburgh, Pa.

Samuel W. McClemens, 216 Haynes St., Johnstown, Pa.

W. M. Pagachnick, 6½ Broadway St., Carnegie, Pa.

James D. Patrick, Electroplating Projects, Westinghouse Electric Corp., East Pittsburgh, Pa.

William H. Rolshouse, Union Switch and Signal Co., Dept. 40, Swissvale, Pa.

K. H. Strader, Lee S. Smith & Son Mfg. Co., 7325 Penn Ave., Pittsburgh 8, Pa.

Lester J. Wolfe, 1022 Gulf Bldg., Pittsburg, Pa.

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Karl Nell, Hickok Co., Rochester, N. Y.

Paul Pasnok, 10 Kelly St., Rochester, N. Y.

SAN FRANCISCO BRANCH

Bruce F. Davis, 92 Seventh St., Oakland 7, Calif.

Jay F. Hackmeier, 1545 Maripos St., Richmond, Calif.

Frank M. Koch, 1201 Bryant St., San Francisco 3, Calif.

Frederick W. Lane, 92 Seventh St., Oakland 7, Calif.

Guy Pilaro, 1141 Howard St., San Francisco 3, Calif.

Raymond L. Sorrells, L. H. Butcher Co., 15th and Vermont Sts., San Francisco 3, Calif.

James F. Tompkins, 5701 Hollis St., Emeryville, Calif.

SOUTHEASTERN BRANCH

George L. McCabe, 662 Gordon Place, S. W., Atlanta, Ga.

SPRINGFIELD BRANCH

Nicholas Hetman, 36 Brown St., Pittsfield, Mass.

Antonio S. Horta, Meadow Rd., Greenfield, Mass.

Harold Oehler, 855 Main St., Holyoke, Mass.

Kosmir J. Valego, 19 Spring St., Chicopee, Mass.

ST. JOSEPH VALLEY BRANCH

Earle R. Bogema, 211 Washington, Sturgis, Mich.

K. A. Kiefer, 1715 Cassopolis St., Elkhart, Ind.

David A. Le Fevre, C. G. Conn, Ltd., Elkhart, Ind.

TOLEDO BRANCH

Earl J. Batdorf, 526 Wood, Wauseon, Ohio

Lawrence G. Gilmore, 6705 Maplewood, Sylvania, Ohio

Allison G. Suckley, 123 W. Superior, Wauseon, Ohio

TORONTO BRANCH

R. H. Cameron, Royal Metal Manufacturing Company, Ltd., Preston, Ont.

E. H. Chippendale, Ideal Brass and Plating Company, 582 Clifton St., Winnipeg, Manitoba
C. C. MacDonald, 2638 Dundas St., W., Toronto, Ontario
G. B. Marsh, 149 Yarmouth Rd., Toronto, Ontario
John Moor, 117½ Coxwell Ave., Toronto, Ontario
Morly N. Rasberry, P. L. Robertson Manufacturing Company, Ltd., Milton, Ontario
J. G. Smith, 483 Ridelle Ave., Toronto, Ontario
Ben Yates, 280 Huron St., Toronto 5, Canada

TWIN CITY BRANCH
Robert H. Berg, 4414 Nicollet Ave., Minneapolis, Minn.
D. Wray Schorr, 2205 Hiawatha Ave., Minneapolis, Minn.

WATERBURY BRANCH
John S. Holley, Apothecaries Hall Company, Waterbury 88, Conn.
Paul R. Mullaney, Y. M. C. A., Waterbury, Conn.

REINSTATEMENT

ROCHESTER BRANCH
John Callaghan

TRANSFERS

S. J. Beyer from Buffalo Branch to Cincinnati Branch
J. Post from Buffalo Branch to Hartford Branch
Howard L. Wright from Philadelphia Branch to Syracuse Branch
Morton Schwartz from Pittsburgh Branch to Los Angeles Branch
Louis Reed from New York Branch to Los Angeles Branch
L. M. Rasmussen from Pittsburgh Branch to Cincinnati Branch
George J. Mitchell from Cleveland Branch to Buffalo Branch
James Guffie from Detroit Branch to Toronto Branch
H. W. Kennedy from Detroit Branch to Indianapolis Branch
James Poulson from Milwaukee Branch to Los Angeles Branch

RESIGNATIONS

CLEVELAND BRANCH
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COLUMBUS BRANCH
Harold Bulkowski
Burt E. Friedl

DETROIT BRANCH
F. K. Clifford
M. Marean
C. T. Wells

HARTFORD BRANCH
Thomas F. Finn, Jr.

LOS ANGELES BRANCH
Frank J. Jurkosky
William H. Orpet
Clarence E. Weinland

MILWAUKEE BRANCH
Fred Baever

NEW YORK BRANCH
Arthur Grinham

PITTSBURGH BRANCH
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E. W. Hopper
Ewart S. Taylerson

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Fred Bing
David Ayers

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Septimus Marland
Paul R. Mullaney

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Ross A. Pringle

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BALTIMORE-WASHINGTON BRANCH
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John S. Brown
Laurence J. Felton

Leon C. Hasker
Gilman Parater, Sr.
Gilman Parater, Jr.
Edward Wallace

BOSTON BRANCH
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Charles R. Culgin
Alfonse Ferullo
Robert Flaherty
Yale J. Greenberg
Calvin T. King
Frank Lorusso
Charles F. Mahoney
Lawrence J. O'Neill
Bernard Olsen
Everett R. Ryan
Samuel Silbowitz
Paul J. Topelian

BRIDGEPORT BRANCH
Thomas M. Barnes, 3rd
Harry Davidoff
Carl Matkowski
Abraham E. Miller
Anthony Turko

CINCINNATI BRANCH
Sidney Baumberger
John Bruns
Walter Helton
H. L. Sendelback

CLEVELAND BRANCH
Walter E. Taves

DAYTON BRANCH
Charles J. Liston
George Nangle
W. R. Sigler

DETROIT BRANCH
C. M. Axsom
J. G. Bell
B. R. Briggs, Jr.
L. P. Brockway
W. Carroll
William Castell
N. Castleberry
J. L. Chmielewski
G. P. Claflin
J. F. Cossey
A. E. Ewald
E. Finney
F. R. Ford
C. J. Forrester
J. Garvie
C. D. Gerard
J. L. Germaine
R. Gilbert
E. G. Graham
R. B. Hammond
R. Hanson
O. C. Haxter
C. C. Hestand
N. W. Hovey
A. J. Johnson
E. G. Jolliff
W. N. Keese
G. A. Lodge
E. G. Lundberg
R. A. McDonald
C. S. Menear
W. G. Mowbray
E. J. Nash
T. J. Orr
R. W. Pflug
J. E. Pitts
F. Puzio
J. L. Reed
P. E. Roberts
F. H. Sanders
H. O. Shultz
M. A. Skevington
R. O. Smith
H. R. Sparr
S. A. Stachowski
H. A. Talbert
R. A. Thomas
A. A. Urban
M. E. Van Landeghem
Andrew V. Re
H. W. Willis
C. H. Wills
A. E. Woodley

HARTFORD BRANCH
Samuel Merman

INDIANAPOLIS BRANCH
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Leland E. Bass
William K. Clark
A. L. Chesterfield
John M. Chesterfield
Hugh N. Davis
Anthony J. Fritz

Ira K. Fuller
Fred A. Hodler
Walter M. Jenkins
Otis K. Jones
James L. Madden
William M. Martz
Carroll F. Matthews
James A. Miller
Otto Miller
George S. Morrison
Donald L. Patrick
Cecil L. Platt
E. W. Pohl
Albert E. Pritchard
Harold E. Rinne
H. Bernard Schock
Roy E. Shockley
Paul J. Simmon
John S. Smith
Charles Walters
F. W. Whipple
Lyle Williams

LANCASTER BRANCH
Charles b. Cupp, Jr.

NEWARK BRANCH
George Arnold
J. LeRoy Barker
Joseph Bolish
Victor Bradford
Joseph G. Di Bernardo
John Dobson
George Galanti
John Gleinig
Joseph Greco
Joseph Gruskiewecz
Frank Hines
Walter Kempf
Frederick Kirkman
Samuel Mortorana
Jack Pettit
Michael Trifoglio
Eugene Villacorta
Arthur Walter
Walter Zahniser
Robert Kuster

NEW YORK BRANCH
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Harold O. Booth
N. Fleet
Frederick H. Hesch
Joseph Koren
John D. Palermo
Edward N. Tripp
Joseph Zappulla

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J. J. Devaney
M. F. Dudek
J. M. Freeburger, Sr.
D. F. Henry
Myer Karlin
James E. Pugh
Louis Sherman
F. R. Skutta

PROVIDENCE-ATTLEBORO BRANCH
Edw. MacDonald

SOUTHEASTERN BRANCH
Arthur J. Hereford

SYDNEY BRANCH
R. V. Fitzgerald
T. O. Kolts
F. A. Wallace

DEATHS

BRIDGEPORT BRANCH
Phillip A. Willett

BOSTON BRANCH
Harry M. Roberts

MILWAUKEE BRANCH
Robert Steuernagel, Sr.

NEW YORK BRANCH
Ben Popper

PITTSBURGH BRANCH
Stewart Martin

PROVIDENCE-ATTLEBORO BRANCH
Charles C. Chace

ST. JOSEPH VALLEY BRANCH
Frank H. Negley

SYDNEY BRANCH
D. E. Willoughby

WATERBURY BRANCH
William J. Cavanaugh

MEMBERSHIP CHART

BRANCH	Membership May 1, 1947	New Members	Net Change in Membership	Per Cent Net Change
FIRST GROUP				
BRIDGEPORT	147	10	+ 5	+ 3.4
CHICAGO	410	12	+12	+ 2.9
CLEVELAND	194	4	+ 1½	+ 0.8
GRAND RAPIDS	136	..	.....	.....
BOSTON	160	..	.....	.....
TORONTO	144	1	− ½	− 0.3
HARTFORD	141	1	− ½	− 0.4
WATERBURY	139	1	− 1	− 0.7
LOS ANGELES	196	..	− 1½	− 0.8
NEW YORK	259	6	− 3½	− 1.4
PHILADELPHIA	218	5	− 4½	− 2.1
NEWARK	257	6	−14	− 5.4
DETROIT	423	11	−33½	− 7.9
SECOND GROUP				
PITTSBURGH	126	10	+ 6	+ 4.8
ROCHESTER	88	2	+ 3	+ 3.4
ST. JOSEPH VALLEY	88	3	+ 2	+ 2.2
BUFFALO	98	2	+ 1½	+ 1.5
SAN FRANCISCO	77	1	+ 1	+ 1.3
TWIN CITY	95	1	+ 1	+ 1.1
MILWAUKEE	124	3	+ ½	+ 0.4
ST. LOUIS	96	..	.....	.....
NEW HAVEN	114	..	.....	.....
PROV.-ATTLEBORO	126	..	− 1	− 0.8
DAYTON	90	1	− 2	− 2.2
BALTIMORE-WASH.	119	2	− 5	− 4.2
INDIANAPOLIS	103	15	−13½	−13.1
THIRD GROUP				
TOLEDO	55	3	+ 3	+ 5.5
SPRINGFIELD	73	4	+ 3	+ 4.1
LANCASTER	38	2	+ 1	+ 2.6
SYRACUSE	73	..	+ ½	+ 0.7
COLUMBUS	35	2	.....	.....
SOUTHEASTERN	43	..	.....	.....
ADELAIDE	49	..	.....	.....
JACKSON-LANSING	49	..	.....	.....
SYDNEY	59	..	.....	.....
MONTREAL	60	..	.....	.....
MELBOURNE	61	..	.....	.....
ROCKFORD	64	..	.....	.....
CINCINNATI	52	2	− 1	− 1.9
TOTAL A. E. S.	4,879	110	−36	− 0.7

Membership, June 10, 1947 4,843

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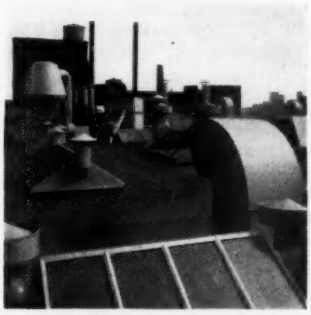

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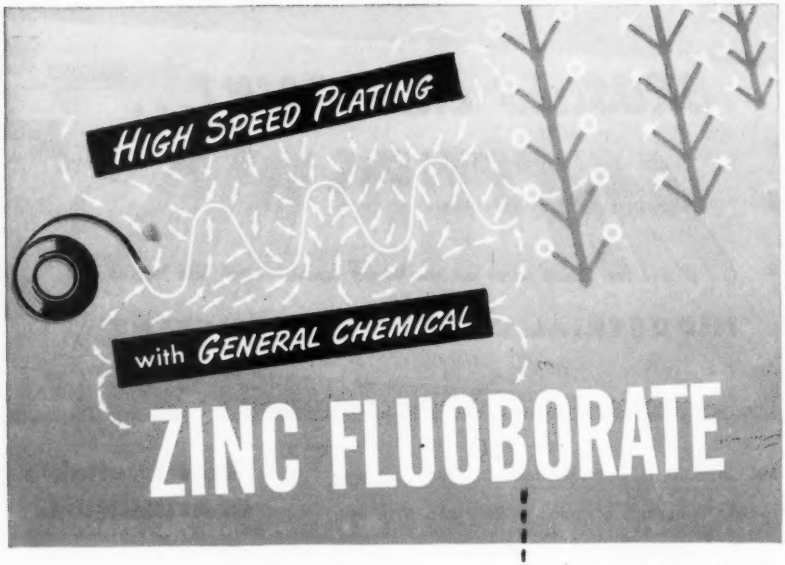

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Job Plating in Volume

HERBERT CHASE. *Steel* **119**, 102–108 (August 19, 1946).

Use of holding fixtures wherever possible for buffing and polishing and conveyorized setups for buffing and plating reduces costs and speeds production without sacrifice of quality.

●

Precision Metal Parts Produced by Electroforming

H. R. CLAUSER. *Materials and Methods* **24**, 112–116 (July, 1946).

Discusses development of the process; electroforming technique; materials that can be electroformed; characteristics, advantages and limitations; uses and applications.

●

Distribution of Current Along a Cylindrical Anode Inside of a Concentric Tube

ARNOLD WEISSELBERG and STAFF. *Trans. Electrochem. Soc.* Preprint **90-1** (1946). 8 pp.

On the basis of actual metal deposits applied with an anode rod concentrically suspended in a cylindrical cathode, mathematical equations are developed for calculating voltage and current distribution along the cylindrical anode.

Gel Lacquer Technique for Protective Coating

CARL J. MALM and HAROLD L. SMITH JR. *Ind. Eng. Chem.*, Ind. Ed. **38**, 937–941 (September 1946).

Application of unusually heavy protective coatings depends upon gelation of lacquer by temperature change alone, without the necessity of solvent evaporation. This behavior is obtained by proper selection and balance of the solvents. Cellulose mixed esters are suitable as bases.

●

A Nomograph for Evaluation of Paint Exposure Panels

N. B. GARLOCK and E. W. McMULLEN. *Official Digest* No. 253, 88–100 (February 1946).

A quantitative rating by means of which large numbers of panels can be compared has been developed. Each type of failure is given a definite weighting in accordance with its seriousness, and a nomograph is constructed by means of which ratings for color, chalk, check, crack, and peel may be integrated into values for protection and for decoration. These values are then combined to derive a final value. When this value drops below 6, repainting is considered necessary. Eight figures illustrate the method; 16 references.

Factors Governing Adherence of Enamels Applied to Sheet Iron

I. A. JOHNSON and E. E. HOWE. *J. Am. Ceramic Soc.* **29**, 296–301 (October 1, 1946).

A series of tests were conducted to ascertain the effect of nickel deposition and firing variations upon the adhesion of enamels applied to special enameling sheets. Limits were established for optimum adhesion of zirconium-opacified white, antimony-molybdenum-opacified white, and commercial blue ground-coat enamels.

●

Finish Testing Equipment, VII

ANON. *Organic Finishing* **7**, 33–36 (July 1946).

Instrument illustrated is used to measure the thickness of dried or baked films of organic finishing materials on magnetic iron or steel. Measurement is made from one side of the film without marking the surface. Standard scale range is 0.0001 to 0.100 inch. Scale range which is extended to 0.300 inch is available.

●

Effect of Spray Technique upon the Porosity of Metal Coatings

A. GLAZUNOV and L. JENICEK. *Paint, Oil and Chemical Review* **109**, 40 (October 3, 1946); Abstract from *Korrosion u. Metallschutz* **20**, 27–30 (1944).

Describes experiments in which variations in gun movement, distance between nozzle and painted surface, air pressure and number of coats were studied. Also describes "electrographic" methods for determination of continuity of the coatings. Results indicate that spraying several coats in order to ensure a continuous coating may result in a considerable waste of material and that conditions should be adjusted to ensure a continuous coating with one spray application.

Electrochemical Treatment of Metals

L. V. NIKITIN and E. A. GRANITCHNOVA. *J. Appl. Chem. U. S. S. R.* **19**, No. 1, 45–54 (1946).

A series of experimental investigations led to the establishment of a formula which shows how the shape of an anode changes with the relative positions of the anode and cathode. A specific coefficient characterizing the degree of surface treatment, the influence of the gravitation field of the earth and the movement of the electrolyte with respect to the electrodes also affect the shape of the anode obtained.

●

Contribution to the Study of Anodic Treatments

EMILE BARET. *Galvano*, No. 107, 13 (1945).

The protection of the surface of aluminum and its alloys by anodic oxidation in a sulfuric acid bath is considered and the mechanism is explained. Formation of aluminum sulfate is regarded as necessary for the formation of a proper surface of aluminum oxide. The author regards the practice of adding aluminum sulfate to a fresh bath as being without either theoretical practical value.

J. S. FIRTZ.

●

Fabrication and Enameling Performance of Titanium Enameling Steel

FRANK R. PORTER. *Am. Ceramic Soc. Bul.* **25**, 259–266 (July 15, 1946).

Results of shop-production runs of titanium enameling steel are presented, and advantages and disadvantages are pointed out. Some recommended design changes are advanced for the successful application of cover-coat enamels directly to the metal and available comparative cost data are given.

Replica Method for Roughness Measurement

H. SMOLUCHOWSKI. *Rev. Sci. Instr.* **17**, 309 (August 1946).

The simple method described can be used in hard-to-get-at places. Cellulose acetate dissolved in acetone is applied. Before it dries, cellulose acetone tape is pressed on. When it is pulled off, the bottom is covered with an accurate replica of the surface. In a variant of the technique, dye is added to the solution so that the replica may be exposed to a light-beam for quantitative roughness determination with a photo-cell.

●

Plating Auto Hardware

HERBERT CHASE. *Iron Age* **158**, 59–61 (September 19, 1946).

Production plating of automobile hardware in a fully conveyorized setup in a Ternstedt plant of General Motors Corporation is described. Racking, solutions and current density for copper cyanide strikes, bright nickel plate, bright copper and chromium plate, and rinsing are discussed in detail.

●

Anodic and Organic Finishes

ANON. *Metal Progress*, 50, 716, 718, 720, 722 (October, 1946).

A brief review summarizing the work of some German investigations. Fischer and Budiloff suggest that the yellow tones produced by oxalic acid electrolytes is the result from some decomposition product of the oxalic acid. Another paper by the same authors reports an explanation for the superiority of bichromate sealing treatment to the effect that the excess bichromate locally reseals the damaged part of the exposed metal by its oxidizing effect. A third article by H. F. Sarx discusses the possibility of using lacquer as coating before working or drawing of sheet.

Codeposition of Tungsten and Nickel from an Aqueous Ammoniacal Citrate Bath

LUTHER E. VAALER and M. L. HOLT. *Trans. Electrochem. Soc.* Preprint **90**-9 (1946) 12 pp.

A new aqueous plating bath for the electrodeposition of tungsten-nickel alloys is described. It contains sodium tungstate, citric acid, nickel sulfate and ammonium hydroxide. When operated at various bath concentrations and conditions of electrolysis, it was found to yield cathode deposits containing from 10 to 35% tungsten.

●

Insulation of Dissimilar Metal Faying Surfaces

W. FLOERSCH. *Automotive and Aviation Ind.* **95**, 37, 88, 90 (October 1, 1946).

Tests are designed to show comparative corrosion resistance of dissimilar metal contacts having various finishing schemes. Among dissimilar metals studied were: 24S-T Dural with cadmium-plated 1025 steel, AMC52S-H magnesium with 18–8 stainless steel, AMC52S-H magnesium with 24S-T Dural and AMC52S-H magnesium with 24S-T Alclad.

●

Estimation of Wetting-Agent Concentration

A. B. ASHTON and N. J. STEAD. *Metallurgia*, **32**, 53–56 (1945), *Chem. Abstracts*, **39**, 4827 (1945).

The concentration of wetting agent in a sulfuric acid-copper sulfate solution (in an electrolytic plant for the recovery of copper dissolved on copper pickling) is determined by measuring the surface tension by means of the capillary rise. The method gives good results for wetting-agent concentrations below 0.30%.

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By GEORGE B. HOGABOOM
Consultant, New Britain, Conn.

No. 2,418,087, March 25, 1947—Method of Heat-Treating Electroplated Material—John S. Nachtman.

CLAIM 2. The method of heat treating material electroplated with a coating of tin for brightening the tin surface which includes vaporizing a hydrocarbon medium of high thermoconductivity and high thermostability which boils between 97° F and 300° F, passing the material continuously through successive portions of said vaporized hydrocarbon medium, heating a first said portion of said medium to preheat the material passing therethrough to a temperature just below the melting point of tin, heating a second said portion of said medium to raise the temperature of the material passing therethrough slightly above the melting point of tin to melt the tin coating, cooling a third said portion of said medium to a point above the vaporizing temperature of the medium but below the melting point of tin to solidify the coating on the material passing therethrough, and then passing the material through a bath of said medium contacting with said third medium portion and cooled to a liquid state to cool the tin coating below its oxidizing temperature.

No. 2,418,088, March 25, 1947—Heat-Treatment of Electroplated Strip Metal—John S. Nachtman.

CLAIM 10. In a method of heat treating metal electroplated with tin, the steps of vaporizing a hydrocarbon medium selected from the group of petroleum and coal tar fractions which boil between about 300° F and 440° F, and then passing the tin coated metal through said vaporized hydrocarbon to condense some of the vapors on the surface of the coated metal heating the coated metal to a temperature below the melting point of the tin coating.

CLAIM 11. A method of continuously heat treating a continuous metallic strip electroplated with tin in the same manner as in Claim 10.

CLAIM 12. The method as defined in Claim 11 whereby the quenching and cooling of the strip to below the oxidizing temperature of tin is carried out in a hydrocarbon medium selected from the group of petroleum and coal tar fractions which boil below the melting temperature of tin.

NOTE: The medium may be a petroleum fraction or solvent known as Varsol. Varsol is a petroleum fraction having a boiling range of about 310° F to 395° F, a flash point of approximately 100° F, a vapor pressure of only 3 mm of mercury at 77° F. Varsol can be heated to the soldering temperature of tin without causing any carbon smudge.

No. 2,418,386, April 1, 1947—Continuous Pickling and Cleaning Device for Metal—Frank J. Wood, assignor to Goodman Manufacturing Company.

CLAIM 1. In an apparatus of the class described, a trough, a plurality of grid blocks disposed along said trough for slidability supporting an article above the bottom of said trough for treatment as it passes along said trough, and means for directing a treating solution to flow across said trough at a high velocity with a whirlpool action at

a plurality of places along said trough above and below the path of travel of the article being treated through said trough, including a plurality of fluid conducting pipes entering said trough along one side thereof above and below the horizontal plane in which the material supporting surfaces of said blocks lie and adapted to discharge fluid under pressure into said trough in a transverse direction with respect thereto, and other pipes entering said trough along the opposite side thereof from said first mentioned pipes above and below the horizontal plane in which the material supporting surfaces of said block lie, for discharging fluid under pressure into said trough in a transverse direction with respect thereto.

No. 2,418,608, April 8, 1947—Corrosion Resistant Metallic Article and Method of Making Same—J. S. Thompson and R. R. Tanner, assignors to Parker Rust Proof Company.

CLAIM 1. A process which comprises applying to an industrial metallic surface a film of an acidulous aqueous solution, the chief compounds in the solution as applied containing the PO_4 radical, hexavalent chromium and a metal having a valence of at least two and acting as a cation, said film containing sufficient chemicals to form a corrosion-resistant paint-holding coat when dried, and drying the film on the metallic surface.

No. 2,419,028, April 15, 1947—Process of Producing Mesh Fabric Stencils—Edward O. Norris.

CLAIM 8. The process of producing mesh fabric stencil which comprises superimposing on a sheet of nickel screen a solid adherent layer of metal other than nickel, filling the interstices of the screen with the same metal, then superimposing on the said layer a second layer substantially thinner than the first layer and of metal differing from the first layer, blocking a design on the said second layer by material resistant to an etchant that acts on the second layer, some of the areas of said design being narrower than the lands of the screen, etching the design through said second layer by means of said etchant, then etching through the first layer by means of a second etchant to which the second layer and the screen are resistant until passages from the uncovered face of the fabric, then about the wires of the fabric, and thence to the etched areas of the second layer are established.

CLAIM 9. The process of producing mesh fabric stencil which comprises superimposing on a sheet of nickel screen a solid adherent layer of copper, superimposing on said layer of copper a solid adherent layer of nickel substantially thinner than the first layer, blocking a design on the said layer of nickel, some of the areas of said design being narrower than the lands of the screen, etching said design through said layer of nickel by means of ferric chloride, then etching through the copper by means of chromic acid until liquid conveying passages leading from the uncovered face of the fabric, then about the wires of the fabric, and thence to the open areas of the layer of nickel are established.

No. 2,418,932, April 15, 1947—Method of Making Enamel Coated Articles—R. E. Harr, assignor to Western Electric Company.

CLAIM 1. A method of coating an article with a vitrifiable material which comprises electrodepositing a layer of nickel-iron alloy containing from 0.5 per cent to 10 per cent of iron on the article in a nickel sulfate, ferrous sulfate solution, employing a nickel anode and an iron anode, maintaining a quantity of metallic iron in a subdivided state in the solution, applying a vitrified material on the alloy layer, and heating the article to fuse the vitrifiable material to form a smooth coating.

NOTE: Solution used

Nickel sulfate	24.0	oz/gal
Sodium chloride	3.0	oz/gal
Boric acid	4.0	oz/gal
Ferrous sulfate	0.067	oz/gal

A quantity of metallic iron, preferably in the form of small particles, is also immersed in the solution but not connected electrically

to the anode or cathode bar. Small metallic iron shot or grit around 90 mesh in size is particularly suitable.

No. 2,418,934, April 15, 1947—Cleaning Machine—C. Hirsch, assignor to American Foundry Equipment Company.

CLAIM 1. A cleaning machine comprising in combination a housing; a pervious belt guided in said housing for movement along a curved path so as to form a tumbling trough in a space of air adapted to receive in said trough parts to be cleaned; a nozzle for discharging a jet of liquid into said trough through said belt from underneath; means for supplying a liquid to said nozzles; means below said belt for collecting liquid passing through said pervious belt; and means for driving said belt.

No. 2,418,955, April 15, 1947—Treatment of Steel Articles—G. E. Hutchinson, assignor to Remington Arms Company, Inc.

CLAIM 1. A method for improving the corrosion resistance of steel articles which comprises subjecting a steel article to a moisture vapor treatment, subjecting the moisture vapor coated steel article to the vapors of a volatile hydrocarbon silicon halide to form a hydrocarbon silicon coating thereon, and then immediately heating to a temperature of between 90° C and 150° C with a current of hot air for about 5 to 100 minutes to drive off the acid formed by the reaction between the vapors of the hydrocarbon silicon halide and the moisture vapor, and to condense the reaction product into a high silicon polymer.

No. 2,418,970, April 15, 1947—Process of Electrolytically Depositing Iron and Iron Alloys—Louis J. Donroe, assignor to Pyrene Manufacturing Company.

CLAIM 2. The process of electrolytically depositing iron and iron-nickel alloys which comprises electroplating through a solution containing ferrous sulfate where iron alone is deposited and ferrous sulfate and nickel sulfate where iron-nickel alloy is deposited, free sulfuric acid in an amount equivalent to from 0.5 cc to about 5 cc per gallon of 66° Baumé acid, and a reducing agent consisting of zinc hyposulfite in an amount sufficient to reduce any ferric iron in the solution to the ferrous state.

No. 2,419,190, April 15, 1947—Conditioning Treatment of Magnesium for Electroplating—H. E. Wagoner, assignor to E. I. du Pont de Nemours and Company.

CLAIM. The process for electroplating a metal selected from the group consisting of magnesium and alloys of magnesium which comprises contacting said metal with a bath comprising essentially a compound selected from the group consisting of monobasic unsaturated acids containing at least one double bond, aliphatic esters of said acids, and heavy metal salts of said acids at a temperature above about 100° C but not higher than about 300° C for a period of about five to thirty minutes, said compound being in the liquid state at the operating temperature, wiping said metal and thereafter electroplating said metal with a heavy metal selected from the group consisting of copper, zinc, cadmium, tin, silver, and gold, from an alkaline plating bath.

No. 2,419,231, April 22, 1947—Electroplated Corrosion Proof Metal Articles and Method of Making Same—D. H. Schantz, assignor to Standard Steel Spring Company.

CLAIM 1. The method of plating articles with nickel-zinc alloy which includes making the article cathode in an electrolyte having a *p*H between about 1 and about 3, in which nickel chloride and zinc salt of the group consisting of zinc sulfate and zinc chloride have been dissolved in sufficient amounts to give to each gallon of the electrolyte a metal zinc content of about seven to nine ounces and a nickel content of about seven to eight ounces, and passing a current having a density of 100 to 700 amperes to the square foot of cathode surface through the electrolyte to the articles.

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INDUSTRY NEWS

New Line of Finishing Barrels

Eleven octagonal *Deburring and Finishing Barrels* of 30-inch diameter and 32 to 60-inch lengths, with nine standard compartment sizes from 12 to 60 inches long, comprise this new line. Design features include 4-speed drive, quick clamp doors, and welded steel construction.

Furnished either plain or with full neoprene lining, the barrels are motor driven at 10, 15, 20, or 30 r p m through a speed reducer and 4-step, V-belt pulleys. To facilitate positioning for loading and unloading, rotation in both directions is controlled by a start-stop lever which applies a hydraulic brake when in the stop position.

Lightweight compartment doors open and close by means of a toggle clamp, and clamping lever permits door to be cracked open for draining before unloading. Doors have a water-tight rubber seal with a takeup adjustment.

All barrels are mounted in a welded tubular steel frame giving free access to the doors for loading. For unloading into a work pan or onto a screen, a 28-inch clearance exists beneath the barrel. Guard rail, pulldown safety hood, and enclosed driving mechanism are safety features. The manufacturer is *Almco Incorporated*, 231 E. Clark Street, Albert Lea, Minn.

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Parts Cleaner Combines Scrubbing and Solvent Action

An automatic multi-flow cold tank Parts Cleaner, the *Model A "Turbulator"*, is actuated by air volume, pressure differential, and gravity. It cleans with a combined liquid scrubbing and solvent action. Tiny metered orifices release compressed air which induces a flow of liquid in the inner tank. Fluid forced under pressure through and around parts cuts each thin film from the surface and deposits particles in a static sludge compartment. Only clean fluid action has scrubbed its way to the bare metal.

This machine will clean most small parts in fifteen to thirty minutes. Once parts are placed in the tank they require no further attention.

Model A is the first of four models planned. Sturdily constructed with no moving parts, its outer tank is 14-gauge steel and the inner 16-gauge, both reinforced with angles. Working space is 36" x 18" x 16"; overall dimensions are 48" x 24" x 24"; working capacity is 104 gallons. The manufacturer is *Turco Products, Inc.*, 6135 S. Central Avenue, Los Angeles 1, Calif.

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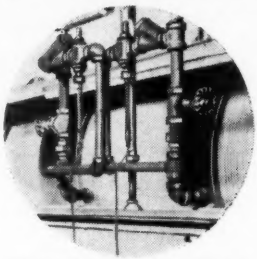
Metal Washing TEMPERATURE CONTROLS

When plating and other processes requiring metal washing or cleaning became streamlined and automatic, the need for reliable temperature control became obvious.

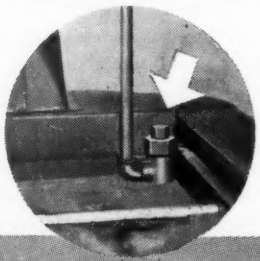
On this page, we illustrate four different Sarco controls used for this purpose. Each is positive in action, simple in construction and relatively low in cost.

Many manufacturers of washing and degreasing equipment install Sarco control as part of the machine, but it is easily added on existing equipment.



Two Sarco type TR-21 temperature regulators controlling barrel type cleaning machine.

For approximate control on cleaning and rinsing tanks, the Sarco Thermoton costs little more than a steam trap.



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Buckingham Products Company in New Large Plant

The Buckingham Products Company, manufacturers of polishing and buffing compositions, has moved to its new plant at 14100 Fullerton Avenue, Detroit.

The new plant has double the producing area of the old plant, with space provided for anticipated production increases.

The company was organized twelve years ago by *R. M. Buckingham*, its president, who has had twenty-seven years' experience in the development and manufacture of metal finishing compounds.

The firm has over thirty-five representatives located in active industrial areas from coast to coast.

As befits a leader in a rapidly growing industry, Buckingham Products Company is active in metal finishing associations.

Optimus Detergents Company Announces New Cleaner for Aluminum

A new metal cleaning compound especially designed for cleaning aluminum, designated as *Optimus No. 101A*, has just been announced by *Optimus Detergents Company*, 120 Water Street, Matawan, N. J., manufacturers of industrial cleaning materials.

Optimus No. 101A is a balanced medium duty alkaline cleaner with a synthetic wetting agent, special water softening materials and inhibitors to prevent attack on the metal. It is particularly effective for cleaning dirt, grease and oil.

It can also be used as a soak or cathodic cleaner for ferrous metals other than aluminum, such as die castings, brass, bronze, pewter, etc. With aluminum, the electrocleaning application does not apply.

Optimus No. 101A is ideal for hot tank applications. A very mild, non-etching type of cleaner, it can be used in small con-

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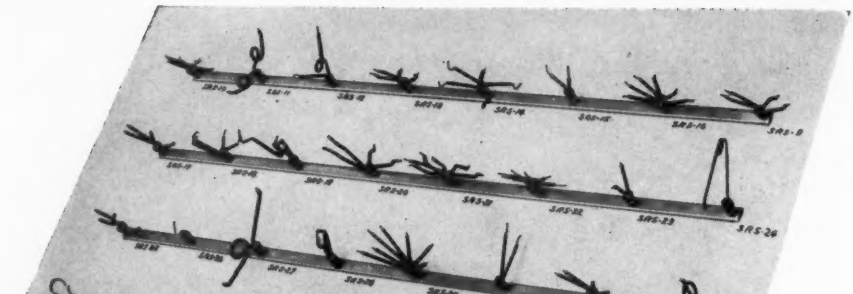

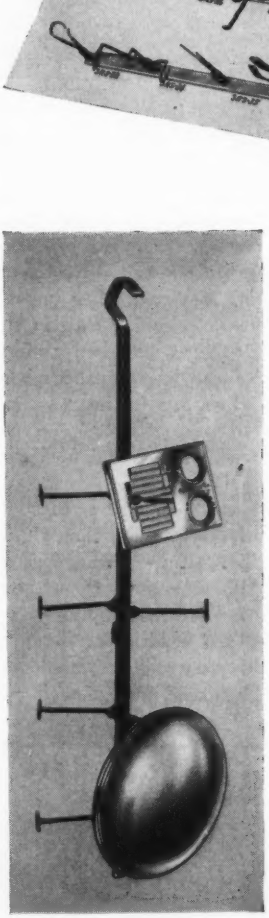

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centrations, with temperature ranging between 140° and 180° F.

A similar material, and a companion product, *Optimus No. 101* is applicable for machine washing operations, where foaming is undesirable.

These materials are available in 100- and 400-pound containers.

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Stop-Off Compound

A new stop-off lacquer, *Kote-Masq*, has been announced by the *Hanson-Van Winkle-Munning Company*, Matawan, N. J.

This product, the result of extensive research, embodies the latest synthetics now available to industry. Production tests have proved its superiority, particularly in providing positive adhesion at the edges. Kote-Masq is recommended for use in any electroplating, electroclean ing or anodizing solution. It can be stored in the original shipping container or one of glass but not in plain tinned or galvanized containers.

Kote-Masq consists of three separate materials: Kote-Masq—the actual stop-off compound in the traditional orange color, *Kote-Thinner*—used to dilute the compound if it should thicken before use, and *Kote-Thinner Grade S*—necessary when spraying but for no other purpose.

Kote-Masq can be removed with a chlorinated solvent liquid or in a vapor degreaser.

•

71-Point Lead Anode

Over 10 per cent increase in efficiency, based on tests by an unbiased authority, is claimed for an improved lead anode of patented design announced by the *Division Lead Company*, 836 W. Kinzie Street, Chicago 22, Ill.

The improved anode has 71 points and each inch of length has 15.5 square inches of surface. Arrangement of the points concentrates gassing to create a rapid flow of solution against the surface. Stagnation is eliminated even down to the bottom of the troughs; the great surface area and the 71 throwing edges are fully utilized. Disintegration is uniform over the entire surface, and the anodes retain high efficiency through a long service life.

There's No Substitute for Quality and Uniformity

HARRISON 4-A PRODUCTS

Superior Buffing and Polishing Compounds
To meet all your requirements

Consult us on your special needs.
We will send samples to meet them.

New Compounds for Spraying or Dipping

HARRISON & COMPANY, INC.

Haverhill, Massachusetts

RACK COATING LASTS 3 YEARS!

A 3-year bath in nickel and chromium—Coating 203 sure can take it!

Unichrome Coating 203 serves record number of cycles

RACKS are kept busy in this plant. Yet this plater found he could practically forget rack maintenance once his racks were protected with Coating 203. He reports that in constant service in nickel and chromium tanks, *they averaged better than 3000 hours!*

That's trouble-free service for you! And consider the savings in recoating costs—and in time—that you can gain with Unichrome Coating 203. A *tough*, air-drying coating, it takes not only severe plating baths, but rough shop handling as well. Write your nearest United Chromium office for prices and details.

UNICHROME

Trade Mark Reg. U.S. Pat. Off.

RACK COATINGS—Products of

UNITED CHROMIUM, INCORPORATED • 51 E. 42nd St., New York 17, N.Y.

Detroit 7, Mich. • Waterbury 90, Conn. • Chicago 4, Ill. • Dayton 2, Ohio • Los Angeles 11, Cal.

Divco 71-Point Anodes are extruded of antimonial lead. The deep-ribbed construction prevents warping and buckling. The bronze hook is hot-lead-dipped and burned directly to the anode, assuring positive current conductance.

•

New Literature on Selenium Rectifiers

Two new bulletins have been recently released by *Richardson-Allen Corporation*, 15 W. 20th Street, New York 11, N. Y., to augment its loose leaf catalog on selenium rectifiers.

One covers the new automatic electronic voltage regulator and gives complete description and illustrations of this table size regulator which maintains a constant dc output voltage regardless of the ampere load current and is designed for 115 volts, single phase 50/60 cycle ac input.

The other covers the general line of all-purpose industrial rectifiers, adaptable for all types of current rectification from ac to dc and supplies any conversion voltage for any current load. The bulletin illustrates various sizes and types and gives specifications and applications.

Commonwealth Engineering Expands

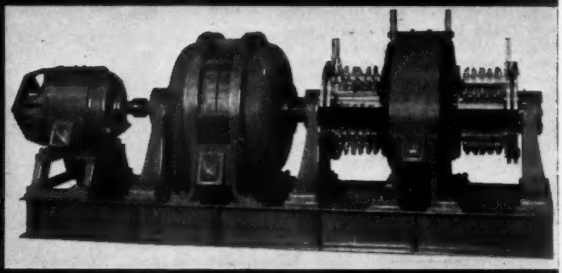
Present research facilities will be more than doubled and many new laboratories will be avilable when *The Commonwealth Engineering Company* of Dayton, Ohio, occupies new quarters here beginning July 1.

New laboratories for research in biologicals, low temperatures, electronics, and instrumentation will occupy the new building. In the adjoining structure, present home of Commonwealth, will be housed the industrial finishes, coated fabrics, plastics, metallurgy, industrial chemistry, hydraulics, and high-vacuum laboratories.

Colonel H. A. Toulmin, Jr., internationally known patent and corporation lawyer, author, and industrialist, is Chairman of the Board of Commonwealth. The president is *C. Palmer Boyles*.

Commonwealth's offices have recently been moved to a downtown location at 1771 Springfield Street, in order to provide additional space in the laboratories. Three small laboratory buildings are also included on the site of the larger structures, to accommodate activities segregated by reason of safety restrictions.

COLUMBIA MOTOR GENERATORS

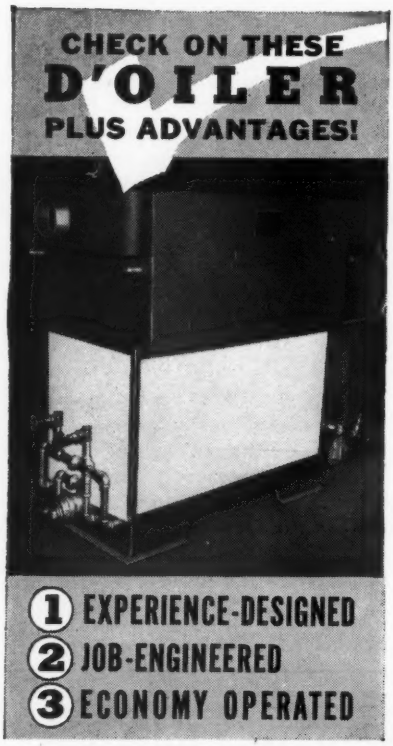


FOR ELECTRO-PLATING

Columbia Generators embody every feature essential for dependable, 24-hour operation. They are built for electroplating service in sizes of 6 to 20 volts, 500 to 20,000 amperes, for anodic treatment of aluminum in sizes of 40, 50, and 60 volts, 500 to 3,000 amperes. Columbia Generators for other electrolytic processes range from ½ to 250 KW, 100 to 40,000 amperes, 6 to 60 volts. Write for full information.

COLUMBIA ELECTRIC MFG. CO.

4519 HAMILTON AVE., N.E. CLEVELAND 14, OHIO



FOR THOROUGH METAL CLEANING

The D'OILER Vapor Spray machine, illustrated above, can be used as a vapor-spray, or a straight vapor degreasing unit. Drain table recaptures dragout from basketed parts . . . all-around insulation reduces heat losses . . . exhaust duct on two sides safeguards operator . . . pump drive for standby solvent eliminates hand pouring.

Every D'OILER type is built to do a specific job . . . is designed with the "on-the-job experience" necessary to provide a degreaser that does the work, in the required volume, economically.

Our engineers will gladly advise on degreasing problems; your inquiries will receive prompt attention. Write today.

Mechanical
PROCESS COMPANY
P. O. BOX 88, SOUTH ORANGE, N. J.

Lubrication Important in Cutting and Grinding on Metal

How Lubricants Affect Cutting and Grinding is the title of an interesting feature article appearing in a recent issue of *Oakite News Service*, bi-monthly house publication of *Oakite Products, Inc.*, New York.

Helpful recommendations for avoiding wheel loading and glazing difficulties, and for obtaining maximum life span of wheel abrasive particles are also given.

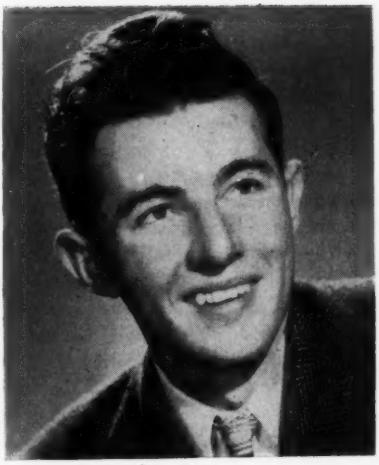
Industry personnel and other readers interested in obtaining a free copy of the issue of Oakite News Service containing this article should address their requests to Oakite Products, Inc., 157 Thames Street, New York 6, N. Y.

•

United Chromium Announces Three Additions to Sales and Technical Staff

To further increase its service to users of Unichrome materials and plating processes, *United Chromium, Incorporated*, reports the appointment of three highly qualified men to its technical and sales organization.

David E. Hartman will act as investigator and provide technical consultations on specialized applications of Unichrome products. His experience includes associations with Harco Products Corporation and the Metal and Thermit Corporation.



Expanding the Los Angeles branch of United Chromium are *Don F. Edwards* and

James Martin. Mr. Edwards, with a degree in chemistry, served with L. M. Schwien Engineering Company as an electroplating chemist and with Goodyear Synthetic Rubber Corporation as a development chemist. Mr. Martin has recently received his degree in chemical engineering.

Each of these appointments will make available to a wider territory Unichrome surface finishes, which include plating processes, materials for the plating plant, synthetics and lacquers for product finishing, and industrial protective coatings.

A RECTIFIER *for* EACH TANK

Better Work... Lower Costs

Greater flexibility in handling varying jobs from tank to tank is assured by the installation of an R-A Selenium Rectifier for each tank. The finest voltage settings for the most difficult job in each tank can be set without overall loss of power. The complete installation is economical too.

Richardson-Allen Selenium Rectifiers are a great advancement in current conversion, engineered and built for long hard service. All units are tested at 25% continuous overload before leaving the factory.

Standard units available for immediate delivery. Write us today for data bulletins and the name of your nearest dealer. He will be glad to give you comparative cost figures on installation and operation.

Consider These Advantages:

1. Continuously variable stepless voltage control sealed in oil.
2. No lag in starting.
3. Adaptable for remote control.
4. Constant efficiency with varying loads.
5. No standby losses when not under load.
6. Internal forced cooling.
7. Thermostatic protection.
8. Units operate in room temperature up to 105° F.
9. Switches and pilot light on both basic and remote control units.

Rectification for Every Application

RICHARDSON-ALLEN CORP.

15 WEST 20th STREET, NEW YORK 11, N. Y.

Sales Engineers Located in Principal Cities

Manufacturers of the most complete line of standard Selenium Rectifiers

RICHARDSON-ALLEN

Selenium Rectifiers

New Filter Catalogue

The importance of Filtration as an aid to finer finished plated work from plating solutions is described and illustrated in a new catalogue entitled "*Alsop Sealed-Disc Filters for Plating Solutions*" which has just been issued by *Alsop Engineering Corporation*, Milldale, Conn.

This new catalogue contains 50 photos and diagrammatic views and 4,500 words describing "*Sealed-Disc*" *Filters* and "*Centri-Poise*" *Pumps* in complete detail as well as explaining the fundamentals of filtration for plating applications.

The text outlines the standard techniques employed today in plating departments, describes the advantages of using filters on practically all types of plating solutions. It shows also various typical installations in different plants.

The "Sealed-Disc" Filter for plating solutions was designed in 1939 after 17 years' previous filtration experience. Now after an additional eight years of constant improvements, the company feels that its latest models will meet even greater success in fulfilling the demands for a dependable filtration system by their positive action, compactness, simplicity, general efficiency, and low operating and maintenance costs.

•

Installation Instructions for H-VM-M Low Voltage Direct Current Motor-Generator Sets

A new Bulletin, *G5-17*, has been issued by the *Hanson-Van Winkle-Munning Company*, Matawan, N. J. This bulletin covers unpacking, installation, preparation of foundations, preparation for starting of the motor-generator sets, care and operation, commutator maintenance, fitting new brushes, electrical maintenance equipment, copper requirements for electroplating busbar installations, and diagrams of connections for induction and synchronous motor-generator sets.

•

Rust Inhibitor Eliminates Drying

The need for drying metal parts before applying rust preventive is eliminated by a new solvent type rust inhibitor, "*Brayco-150*", which has exceptional ability to dis-

CHROMIUM
NICKEL
COPPER

Simple test sets for aid in controlling plating and other solutions.

Write for literature.

KOCOUR CO.

4801 S. ST. LOUIS AVE.
CHICAGO 32, ILL.

Specify Kocour Sets from your supplier.

place all moisture from metal surfaces. Due to its high affinity for metal, it penetrates underneath water to the metal, forcing water to drain off and preventing it from again adhering. Thus parts may be removed from any bath and dipped or sprayed with it after which moisture will run off.

The inhibitor consists of a film-forming, non-volatile base dissolved in a petroleum solvent. The solvent evaporates leaving an oily film which resists corrosion caused by heat, cold, humidity, and salt water. A thin film affords protection for six to twelve months indoors and for limited periods out-of-doors.

The manufacturer is *U. B. Bray Company*, 3344 E. Medford Street, Los Angeles 33, Calif.

•

New Burnishing Compound

A burnishing compound, "*Metex*" *No. 15*, is being marketed by *MacDermid, Inc.*, Waterbury, Conn. It is claimed that the compound assures a bright luster on copper, brass, nickel and stainless steel without using steel burnishing balls, and is efficiently in one to three oz/gal concentrations

Hammond of KALAMAZOO
FINISHING PRODUCTION REACHES A NEW PEAK
HAMMOND
BACKSTANDS
CONVERT GRINDERS and POLISHERS into high production
ABRASIVE BELT UNITS
MODEL No. 3
Above: "VRO" Polishing Lathe with two No. 3 Backstands.
WRITE FOR CATALOG NO. 55
—covering complete line of Hammond equipment.
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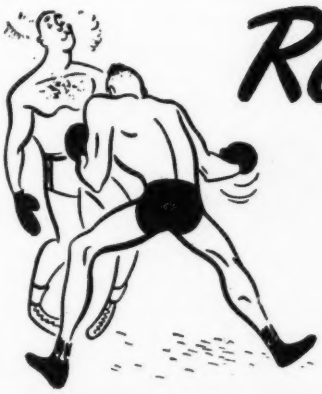

Ready for the Finishing Touch!

...METAL PARTS ARE MORE EASILY FINISHED WHEN CLEANED IN A

BLAKESLEE

METAL PARTS WASHER

G. S. BLAKESLEE & CO.

BLACOSOLV DEGREASERS AND SOLVENT

NIAGARA METAL PARTS WASHERS

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Cleanse & Purify your Zinc Solution with

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TRADE MARK REG'D.

Make your Zinc Bright

Information free—wire collect

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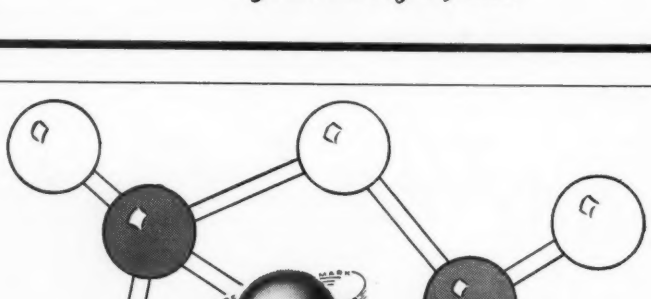
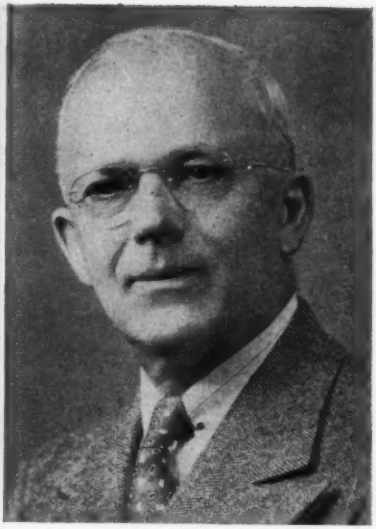


INTEGRAL PART OF INDUSTRY PAST, PRESENT —AND FUTURE

THE ABBOTT BALL COMPANY, HARTFORD 10, CONN.



Frank C. Mesle Honored

Frank C. Mesle, Past President of the A. E. S. and author of many outstanding papers on silver plating and allied subjects, was recently honored by *Oneida, Ltd.*, Oneida, N. Y., manufacturer of silverware, for fifty years of devoted service with the company, according to the Syracuse Post-Standard. A gold watch was presented to him by P. B. Noyes, president of the company.

Our heartiest congratulations.

•

Gas-Fired Cleaning Tank

D. C. Cooper Company, 1467 S. Michigan Avenue, Chicago 5, Ill., offers a *Gas-Fired Tank* for cleaning large and small parts, and for stripping paints, baked enamel, and lacquers from steel and iron parts.

Built of heavy gauge metal to sustain the rugged and frequent knocks of heavy equipment, it is equipped with 4-inch heating pipes in the bottom of the tank. Fumes are removed through a duct, extending the length of two sides and the back of the tank, to which an exhaust fan can be connected. Complete with thermometer, drain, and overflow connections, it can be equipped with an automatic agitating device. Several models are available, and units equipped with steam coils for use where steam heating is desired may be had.

Custom-Built
TANKS
For Cleaning, Pickling and Plating

● For 39 years leading manufacturers have relied on Kirk & Blum for custom-built tanks to meet their individual production requirements.

We are equipped to fabricate tanks of Steel, Lead or Rubber Lined, Monel Metal, Stainless Steel, Copper, Aluminum, Inconel, etc.

Tanks are supplied with or without exhaust ducts and fans as conditions or specifications indicate.

KIRK AND BLUM
The KIRK & BLUM Mfg. Co.
2887 Spring Grove Ave.
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Slightly Used
BUFFS

LOOSE & SEWED
ANY QUANTITY
ALL SIZES

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"YANKEE BRAND"

PROGRESSIVELY BETTER ABRASIVE COMPOUNDS

Tailored to fit all finishing requirements.

Inquiries respectfully solicited

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FOUNDRY FACINGS

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PERMAG

for
Quick Efficient
Cleaning of Metal
Surfaces prior to Plating

PERMAG Cleaning Compounds are used in still tank also with direct or reverse current.

PERMAG produces a perfectly clean surface quickly, economically insuring a perfect finish on metals. Never injures soft metal surfaces.

More details on request.

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Buffing Compositions
Nickel Anodes
Chemicals
General Supplies
Equipment

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(NOT INC.)

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Zialite

Reg. U. S. Pat. Off.

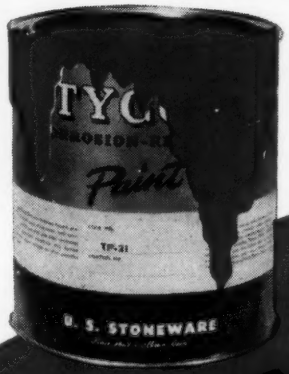
FOR NICKEL PLATING

The one bath especially designed for plating diecastings made of WHITE METAL ALLOYS including ZINC, LEAD, and ALUMINUM.

USE
Zialite
ADDITION AGENTS
for
HARD CHROMIUM BATHS

Finer-grained deposits.
Increased throwing power.
Less sensitivity to sulfate content.

ZIALITE CORPORATION
92 Grove Street, Worcester 5, Mass.



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The ALL-PLASTIC PROTECTIVE COATING for METAL, WOOD, CONCRETE

RESISTS ACIDS, ALKALIES, WATER, OIL ALL PLATING SOLUTIONS

Cut costly maintenance expense with Tygon Paint—the *all-plastic* protective coating that resists the toughest corrosives. Use it on your structural steel work, exteriors of plating tanks, pipe, generators, rectifiers—in fact anywhere corrosive attack may cause damage. It's easy to apply, available in colors, and, electroplaters tell us, outlasts, outwears any coating they've used.

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ADELAIDE AUSTRALIA. Acting Secretary, G. N. Dixon, G. P. O. Box 428D, Adelaide, Australia.

BALTIMORE-WASHINGTON meets first Tuesday of each month in October, December, February and April in Baltimore, Md., and in November, January, March and May in Washington, D. C. Secretary, Grace Riddell, Chemistry Division, National Bureau of Standards, Washington 25, D. C.

BOSTON meets first Thursday of each month in Hotel Statler, Boston, Mass. Secretary, Dr. George P. Swift, 53 Galen Street, Watertown 72, Mass.

BRIDGEPORT meets first and third Friday of each month in Barnum Hotel. Secretary-Treasurer, Joseph G. Sterling, 134 Colony Street, Bridgeport 8, Conn.

BUFFALO meets second Friday of each month in Hotel Statler, Buffalo, N. Y. Secretary, J. Ruff, 473 Breckenridge St., Buffalo 13, N. Y.

CHICAGO meets second Friday of each month at 8 P. M., in Atlantic Hotel. Sec y-Treas., J. M. Andrus, 3701 Ravenswood Ave., Chicago 13, Ill.

CINCINNATI meets on fourth Wednesday of each month at 8 P. M., in Engineering Society Headquarters, McMillan Street and Woodburn Avenue, Cincinnati Ohio. Secretary-Treasurer, L. M. Rasmussen, 3228 Brotherton Rd., Cincinnati 9, Ohio.

CLEVELAND meets first Friday of each month in Cleveland Hotel, at 8 P. M. Secretary-Treasurer, George B. Svenson, 2059 Hamilton Avenue, Cleveland 14, Ohio.

COLUMBUS meets first Friday of each month in Battelle Memorial Institute Auditorium, 505 King Avenue, Columbus 1, Ohio, at 8 P. M. Sec'y-Treas., Bernard J. Agruss, 505 King Ave., Columbus 1, Ohio

DAYTON meets second Friday of each month in Engineers' Club, Dayton, Ohio. Secretary Treasurer, Elmar W. Rehme, 505 Commercial Bldg., Dayton 1, Ohio.

DETROIT meets first Friday of each month in Hotel Statler. Secretary-Treasurer, F. L. Clifton, 16536 Inverness, Detroit 21, Mich.

GRAND RAPIDS meets second Friday of each month, 7:30 P. M., in Rowe Hotel. Secretary, Jacob M. Hage, 553 Prospect Ave., S. E Grand Rapids 6, Mich.

HARTFORD meets third Monday of each month in Hotel Bond, Hartford, Conn. Secretary, A. J. Dankevich, 63 Massechussetts Ave., New Britain, Conn.

INDIANAPOLIS meets first Wednesday of each month at Fox Steak House, 1207 Washington Street. Secretary-Treasurer, James J. Monagle, 1464 W. Colorado Ave., Indianapolis, 1, Ind.

JACKSON-LANSING meets second Tuesday of each month at Home Dairy Company in Lansing. Secretary-Treasurer, U. J. Forsyth, 1816 Ada Street, Lansing 10, Mich.

LANCASTER meets second Friday of each month, at 8 P. M., in Thaddeus Stevens Industrial School, Lancaster, Pa. Secretary-Treasurer, H. Clay Brubaker, 881 Manor Street, Lancaster, Pa.

LOS ANGELES meets second Monday of each month, at 6:30 P. M., in Hotel Cabrillo, 11th and Broadway. Secretary Dean D. Williams, 2728 W. 42nd St., Los Angeles 43, Calif.

MELBOURNE, AUSTRALIA. Secretary, L. A. Francis, G. P. O. Box 4502.

MILWAUKEE meets first Friday of each month in Red Arrow Club, 774 N. Broadway. Secretary-Treasurer, James Durnford, 2370 N. 32nd Street, Milwaukee 10, Wis.

MONTREAL meets first Tuesday of each month in Mount Royal Hotel, Montreal, Quebec, Canada. Secretary-Treasurer, William L. Glover, 754 Second Avenue, Verdun 19, Quebec, Canada.

NEWARK meets first and third Friday of each month in Hotel Robert Treat, Newark, N. J., at 8 P. M. Secretary-Treasurer, George Wagner, 1130 S. Long Avenue, Hillside, N. J.

NEW HAVEN meets second Tuesday of each month alternating between Sterling Chemistry Laboratory, Yale University, and Hotel Taft. Secretary-Treasurer, B. J. Gaffney, 40 Filbert Street, Spring Glen, Hamden 14, Conn.

NEW YORK meets second and fourth Fridays of each month, in Hotel Pennsylvania, 7th Avenue and 33rd Street, New York, N. Y. Secretary-Treasurer, Franklyn MacStoker, 25 Princeton Street, Garden City, L. I. N. Y.

PHILADELPHIA meets fourth Friday of each month in Harrison Laboratory Building, University of Pennsylvania, 34th and Spruce Streets. Secretary, Paul Mentzer, Sr., 7242 Bingham Street, Philadelphia 11, Pa.

PITTSBURGH meets third Thursday of each month at 6:30 P. M., in Keystone Hotel. Secretary-Treasurer, R. A. Dimon, 210 Semple Street, Pittsburgh 13, Pa.

PROVIDENCE-ATTLEBORO meets the third Monday of each month in Providence-Biltmore Hotel. Secretary-Treasurer, Edward A. Parker, 111 Glen Ave., Glen Rock, N. J.

ROCKFORD meets second Monday of each month in Faust Hotel. Secretary, Vern T. Wissen, Forest Hills Rd., Rockford, Ill.

ROCHESTER meets third Friday of each month in Hotel Seneca. Secretary, Robert L. Flint, 78 Durand Drive, Point Pleasant, N. Y.

SAN FRANCISCO meets second Thursday of each month, alternating between St. Julien Cafe in San Francisco and Victor's and Roxie's Cafe in Oakland. Secretary-Treasurer, F. W. Huntington, 1621 Lafayette St., Alameda, Calif.

SPRINGFIELD meets fourth Monday of each month in Hotel Charles. Secretary-Treasurer, L. R. Fountain, 15 Cortland Street, Springfield, Mass.

ST. JOSEPH VALLEY. Secretary, Raymond A. Friend, 1435 Howard Street, Niles, Mich.

ST. LOUIS meets second Wednesday of each month in York Hotel, 6th and Market Streets. Secretary-Treasurer, E. R. Hunleth, 4415 Michigan Avenue, St. Louis, Mo.

SOUTHEASTERN meets second Thursday of each month in Robert Fulton Hotel, 114 Lucky Street N. W., Atlanta, Ga. Secretary, William T. Weymouth, 173 Clay St. S. E., Atlanta, Ga.

SYDNEY, AUSTRALIA. Secretary-Treasurer, John Godfrey, P. O. Box 31, Auburn, N. S. W., Australia.

SYRACUSE meets second Friday of each month in Bowne Hall, Syracuse University. Secretary, N. F. Murphy, 523 Allen Street, Syracuse 10, N. Y.

TOLEDO meets first Thursday of each month in the office of Vic Miner Company, 329 20th Street, Toledo, Ohio. Secretary, Gaston Bergeman, 703 Pine Street, Fremont, Ohio.

TORONTO meets second Friday of each month in Royal York Hotel. Secretary, Leonard W. Wray, 105 Ronan Avenue, Toronto 12, Ont., Canada.

TWIN CITY meets first Monday of each month, October through June, in Covered Wagon Cafe, Lodge Room, 114 S. 4th Street, Minneapolis. Secretary-Treasurer, Robert L. Buckley, 318 Builders Exchange, Minneapolis 2, Minn.

WATERBURY meets second Friday of the month in Elton Hotel. Secretary-Treasurer, Spencer L. Henn, P. O. Box Dr. B, Cheshire, Conn.

PLATERS

FOR SALE—THE FOLLOWING EXCELLENT REBUILT AND GUARANTEED ELECTROPLATING MOTOR GENERATOR SETS, WITH FULL CONTROL EQUIPMENT:

2—15,000/7500 AMPERE, 6/12 VOLT, **COLUMBIA ELECTRIC COMPANY** Latest Design Units, with Separate M. G. Exciters.
1—5000/2500 AMPERE, 10/20 VOLT, **HANSON-MUNNING COMPANY,** Synchronous Motor Drive. Built 1941.
2—5000/2500 AMPERE, 9/18 VOLT, **CHARLES F. L'HOMMEDIEU** "RELIANCE" Units, Synchronous Motor Drive, Latest Design.
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1—4000/2000 AMPERE, 6/12 VOLT, **HANSON & VAN WINKLE COMPANY,** Compound Wound, Separately Excited.
1—2500/1250 AMPERE, 6/12 VOLT, **HANSON & VAN WINKLE COMPANY,** Shunt Wound, Separately Excited.
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1—1500/750 AMPERE, 6/12 VOLT, **COLUMBIA ELECTRIC COMPANY,** Latest Design, Separately Excited.
1—1500/750 AMPERE, 12/24 VOLT, **CHANDEYSSON ELECTRIC CO.** Unit, Synchronous Motor Drive. Direct Connected Exciter.
1—1000 AMPERE, 25 VOLT, **HANSON-VAN WINKLE-MUNNING COMPANY,** Separately Excited—Anodizing Unit.
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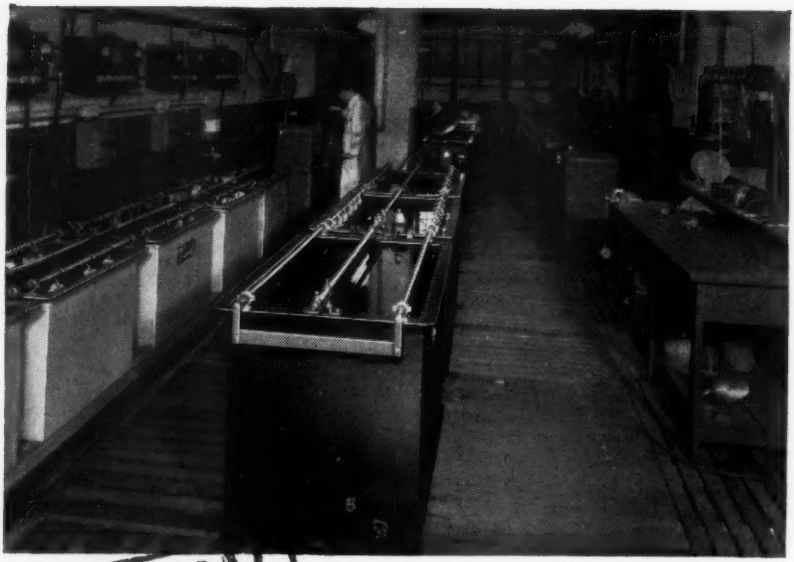

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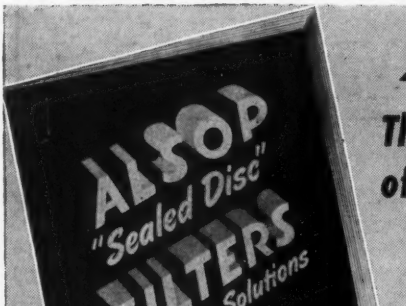

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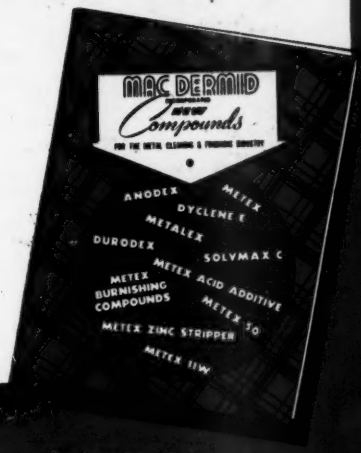

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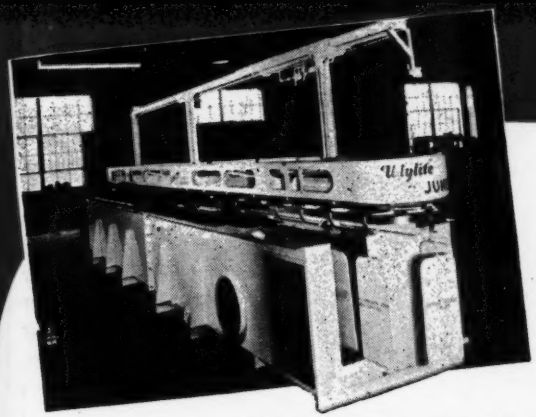

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